Heating Piping & Air Conditioning

with which is merged the Aerologist

Design, Installation, Operation, and Maintenance: Industrial, Commercial, Institutional, and Public Buildings

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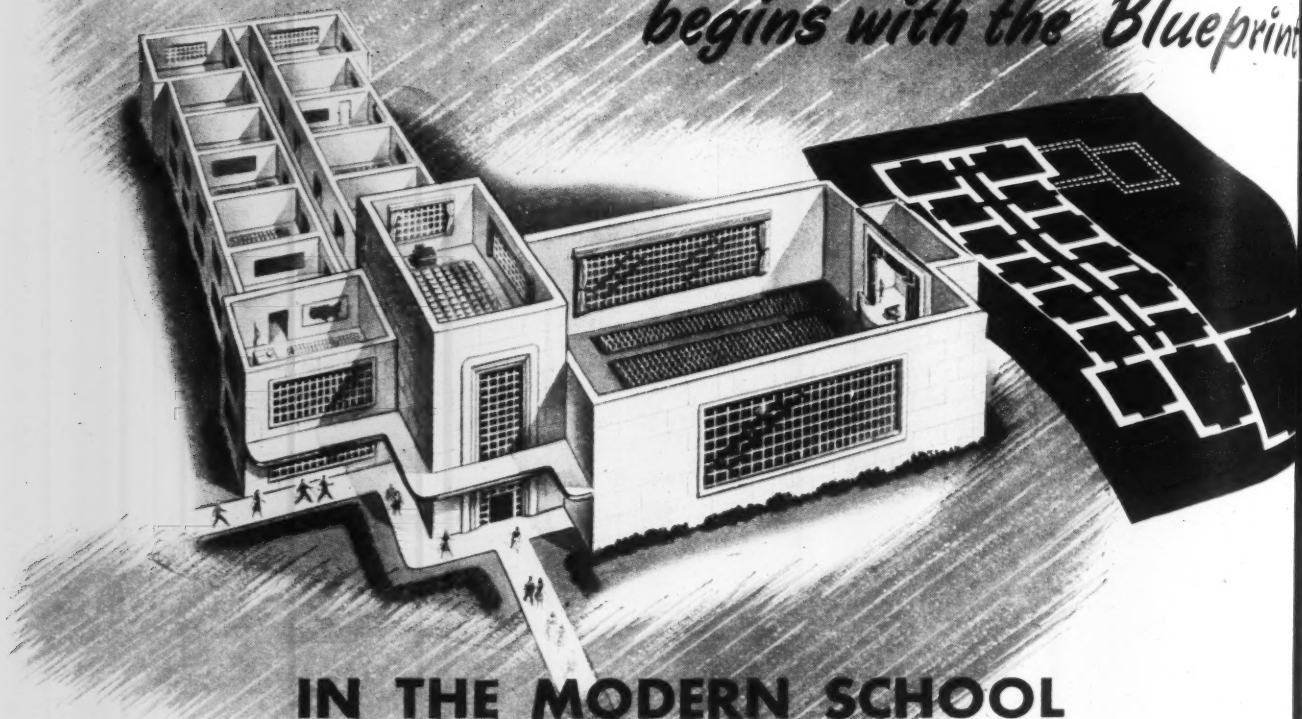

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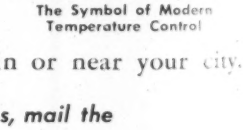

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THE EDITOR'S PAGES

GENERAL CONTRACTORS SURVEY '49 CONSTRUCTION

Construction costs are stabilizing or showing a tendency to decline slightly, according to replies to a nationwide survey conducted by the Associated General Contractors of America for its recent 30th annual convention.

The replies came from the more than 100 local affiliated contractor associations and directors representing the association's more than 5000 member general construction firms. These firms build industrial, commercial, and institutional buildings, highways and airports, and construct heavy engineering projects in all parts of the country and overseas.

The replies to the survey indicated that:

1) There will be again a high volume of construction in 1949. There have been estimates that the potential volume of new construction could exceed the $17.7 billion record of 1948. The contractors reported the immediate outlook is that increases in public works will tend to offset indicated reductions in industrial and commercial construction.

2) Materials—except for steel, and in some areas cement—and construction machinery—except some of the heavier and specialized items—are in relatively plentiful supply after years of shortages.

3) That the critical shortages of skilled workmen in recent years in most communities are being replaced by a more plentiful supply of craftsmen. A few reported local unemployment in the construction trades.

TOO LARGE STEAM LINE CAUSES TROUBLE

Regardless of the thickness of insulation used, a surprisingly large loss of steam superheat may occur if the diameter of the steam line is too large for the desired steam flow conditions, according to the Magnesia Insulation Manufacturers Association.

Such a case occurred recently in a plant where an outdoor line, 6 in. in diameter and 925 ft long, with an ambient air temperature of 80 F, was used to transmit superheated steam at 250 psi and 600 F. The line was insulated with 2-5/16 in. thick 85 percent magnesia pipe insulation. However, the steam temperature at the end of the line was only 450 F.

An analysis indicated that the steam velocity in the line was only a little over 1300 fpm, whereas it should have been between 6000 and 10,000 fpm. The result was that, due to the relatively large size of the pipe and the relatively low steam velocity, there was a large drop in superheat. The investigation showed also that simply increasing the amount of insulation would have no appreciable effect on the extent of superheat loss. The recommendation was that it would be cheaper and more satisfactory to replace the 6 in. line with a $1\frac{1}{2}$ or 2 in. line, insulated with 3 in. thick 85 percent magnesia.

SALES IN LAST QUARTER OF '48 ESTABLISH RECORD

Minneapolis-Honeywell Regulator Co. has reported net earnings of $5,942,008 for 1948, after providing $3,790,000 for taxes on income. Net earnings for 1947 were $6,693,509 after providing $4,381,100 for income taxes.

Net sales for 1948 were $57,600,527 compared with $60,596,021 the year previous, Harold W. Sweatt, president, stated.

During the first two quarters of 1948 the heating industry, for the first time since the war, noted a marked seasonal decline in orders, Mr. Sweatt said. The repercussions were felt immediately in the form of limited demand and substantial cancellation of orders. The drop in heating control sales was directly influenced by the many uncertainties centering about the availability of the various heating fuels. These uncertainties reflected the fuel scarcities of the 1947-1948 heating season and had the effect of postponing public demand for practically all types of heating equipment.

Clarification of the fuel situation later in the year enabled the company to move ahead with its marketing plans, Mr. Sweatt continued, and largely contributed to the result that in the last quarter of the year overall sales established a new peacetime record.

IRON AND STEEL HEAVY SCRAP DRIVE CONTINUES

The improvement in supplies of heavy steel scrap is only relative, according to Secretary of Commerce Charles Sawyer. In commenting on the nationwide drive for heavy scrap collection, sponsored by his department, in cooperation with other federal agencies and industry, he said recently, "Actually, one million more tons of heavy steel scrap are still needed to maintain full steel mill and foundry production. I therefore urge industry to continue its efforts to collect all unneeded iron and steel items and get them into normal scrap collecting channels."

The need for continuing the drive was also recently pointed out by Robert W. Wolcott, chairman, American Iron and Steel Institute's committee on iron and steel scrap. He said, "I have been somewhat concerned recently because many persons, upon learning that supplies of iron and steel scrap are larger, have concluded it is therefore futile to make a special effort to get more and better quality scrap at this time.

"Inventories of scrap have improved, it is true, but at the same time production of steel has increased sharply. Thus, the steel industry is consuming scrap at a record high rate. Furthermore, the companies of the industry are scheduled to increase their present capacity by more than two million tons during this year.

"The metallics needed to produce steel at the present high rate and to make effective the proposed and large capacity of the industry must come from two sources: From ores smelted in blast furnaces, and from steel scrap. The use of scrap, therefore, saves iron ore, as well as contributing to efficiency and economy in operation."

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THE EDITOR'S PAGES

HOSPITAL PROGRAM IS BIGGEST EVER

With over $400 million in total construction costs approved under the hospital survey and construction act since its passage in 1946, the United States is embarked on the most comprehensive hospital construction program attempted by any nation, George L. Read, chief construction engineer, division of hospital facilities, U. S. Public Health Service, said at the 30th annual convention of the Associated General Contractors of America held in New York. Approximately 20 percent of the projects approved are already under contract, and a few are completed, he announced.

COIL INDUSTRY DEVELOPING STANDARDS

Under the guidance of the joint coil committee of the Refrigeration Equipment Manufacturers Association and the Air Conditioning and Refrigerating Machinery Association, Inc., the commercial refrigeration industry is making progress in the development of recommended industry standards for blower coils.

The committee had its inception in January 1948, at the REMA convention, when the low side equipment product section pointed out that there was a need for standards which could be used as a guide by the entire industry.

The committee has outlined its four principal objectives as:

1) To develop suitable industry standards for forced circulation air coolers for refrigeration covering recommendations on methods of testing and rating, minimum standard equipment, safety requirements, and minimum published data.

2) To recommend application standards pertaining to forced circulation air coolers for refrigeration.

3) To develop suitable industry standards for natural convection air coolers for refrigeration covering recommendations on methods of testing and rating, minimum standard equipment, safety requirements, and minimum published data.

4) To recommend application standards pertaining to natural convection air coolers for refrigeration.

D. D. Wile, chief engineer of Refrigeration Engineering, Inc., is chairman of the committee, and S. F. Shawhan, director of development, air conditioning, Carrier Corp., is vice chairman and secretary. L. C. Bastian, the ACRMA's standardization engineer, is recording secretary.

ASA APPROVES UNIFIED SCREW THREAD SYSTEM

The American Standards Association, 70 E. 45th St., New York 17, N. Y., recently gave its final approval to a new American Standard which puts into effect the unified screw thread system agreed upon by Great Britain, Canada, and the United States by the "declaration of accord" signed in Washington last November. The British Standards Institution and the Canadian Standards Association are working on similar standards to put the unification plan into effect in their countries.

This standard, Unified and American Screw Threads for Bolts, Nuts, and Other Threaded Parts, B1.1-1949, presents in tables, diagrams, and formulas the dimensions of the unified threads, as well as those threads which for the time being remain standard in the United States alone.

CITES BENEFITS OF STANDARDIZED BOILERS

At the 27th fuel engineering conference of Appalachian Coals, Inc., held in Detroit last month, Donald S. Walker, vice president of Combustion Engineering - Superheater, Inc., appraised benefits to be derived from standardized design of industrial boiler units.

The main reasons for advocating standardization are the ever increasing costs of labor and material. World War II proved that boiler plants could be built at construction rates previously thought unattainable. This was accomplished by substantially duplicating existing designs and plants. Similar advantages may be realized in peacetime.

Mr. Walker termed "engineers whims" on the part of the manufacturer as well as the purchaser as a cause of much unnecessary expense and pleaded for specification of certain basic items, leaving details to the boiler manufacturer. He stated that his company had standardized on industrial boilers of 250 psig, 500 psig, and 700 psig with capacities from 10,000 to 200,000 lb per hr steam output. For these units design is fixed, with outlets, for example, located where shown—and not several inches from that point. In this manner shipment can be made in reasonably short periods at a price substantially below a tailor-made, specially designed unit.

REPORTS FACTORY SALES OF STOKERS

Factory sales of mechanical and automatic coal stokers of all sizes and types for the year 1948 totaled 85,378 units as compared with 68,908 units in 1947 and 190,918 units in 1946, according to data released by the bureau of the census, U. S. Department of Commerce, says the Stoker Manufacturers' Association. The report represents data for all known producers of stokers in the United States. Statistics cover factory sales to distributors and dealers, and in the case of the larger sizes of industrial stokers, sales are made direct to users under individual engineering specifications and contracts.

RECORD BUSINESS VOLUME IN '48

General Electric Co. and its consolidated affiliates did a record volume of business in 1948, the sales billed to customers having totaled $1,632,700,000 or 13 percent more than in the previous peak wartime year of 1944 and 23 percent more than in 1947, Charles E. Wilson, president, announced last month.

A significant point is that the 1948 and 1947 earnings were equivalent to only 7.6 and 7.2 cents, respectively, on each dollar of sales, whereas in prewar years the company's earnings averaged 11.6 cents on the sales dollar, Mr. Wilson said.

"OPEN for DISCUSSION"

DO YOU HAVE something to say about any of the articles published this month? An additional comment, or perhaps a question on some point? We follow here the custom of engineering society meetings in allowing a period for discussion following presentation of a paper. You are invited to contribute your views. Address them to the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2

STRETCHING DEHUMIDIFIER PERFORMANCE

I HAVE read with a great deal of interest Peter Franck's article in the March issue on a "run around" method of increasing the performance of chemical or adsorption type dehumidifiers. This method is not new and has been used in a number of instances to increase the capacity of a given size of machine rather than expending additional money for the next larger size unit, and it has many merits which Mr. Franck has brought out in his article.

I am very much interested in the development of the formula which Mr. Franck has made for determining the leaving moisture content for equivalent dew point for this type of cycle. Mr. Franck refers to the graph on page 682 in the 1948 ASHVE Guide as the curves on which he bases the development of his formula. I would like to bring out that this graph is the performance characteristic curve of a rotary type dehumidifier which has the characteristics of having a fixed leaving dew point for a fixed entering dew point. This is not characteristic of any other machine except the dehumidifying equipment using a liquid sorbent. Most machines today are the fixed bed type with single bed or dual bed and having a characteristic of the effluent dew point gradually increasing from the beginning of the cycle to the end of the cycle with a constant dew point entering.

This makes the problem a little more complex in that each machine has entirely different characteristics due to the time-adsorption rate which may be inherently built in the machine. This would involve additional exponential functions in the formula which must include the time rate of the adsorption cycle and also take into consideration with this time rate the thickness of the bed, the type of material used which will be a function of the adsorption capacity, and the extent to which reactivation is controlled; that is, in some instances the reactivation may only go down to a net adsorption weight of 10 percent, while in other cases reactivation may be carried out to where the material may only have 5 percent moisture by weight. The air velocity through the bed and the entering dew point also are considerations which must be included in any empirical formula which may be developed for this purpose.

I hope that Mr. Franck will continue with his studies on this subject and try to prepare a formula which will be of assistance in determining the value of a "run around" cycle for fixed bed machines which have similar characteristics although not at the same level; in other words, it would mean the development of a family of curves or possibly a formula with exponential functions which may be related to a table. With the dehumidification industry in its infant stage, it is the type of work that Mr. Franck has done in this article which is definitely needed and I hope he will continue with his studies along this line in order that the industry may benefit from his work. — JOHN EVERETTS, JR., Urdahl & Everetts, consulting engineers, Washington, D.C., and chairman, ASHVE technical advisory committee on sorbents.

MANY WAYS TO HOOK UP DEHUMIDIFIERS

PETER FRANCK'S article in the March issue on Stretching Dehumidifier Performance is a very fine one and a worthwhile contribution to the art of dehumidification. The comments below are constructive criticism which are made in the interests of accuracy and are points which I believe should be considered.

We have been applying this type of system on some jobs for the past 12 years. In working them out we have always resorted to a "cut and try" method for finding the equilibrium point so that the method which Mr. Franck has worked out will be very helpful.

There are many ways of hooking up dehumidifiers to accomplish specific results. Everything else being equal, the method which is the subject of this article gives less capacity than any other hookup. In explanation of this point, let us consider two other standard hookups compared with this "chase around" scheme and disregarding the seal leakage problem which is brought up later:

Let us consider first the chase around system using a dehumidifier having a capacity of 800 cfm operating with 400 cfm of outside air at 130 grains per lb and 400 cfm of bypassed air and—of course—400 cfm delivered to the space. In order to eliminate the variable of temperature, we will consider that the air temperature is 75 deg for all examples. With the chase around system, it will work out that the equilibrium moisture content of the air leaving the dryer will be 24 grains per lb, so that we will have sent to the space 400 cfm of air at 24 grains. If we arbitrarily assume that we wish to hold 40 grains in the space, this hookup will be capable of adsorbing 480 grains per min internal moisture load.

This compares with a more standard hookup using 800 cfm with again 400 cfm outside air at 130 grains and 400 cfm of recirculated air from the space at 40 grains. The mixture entering the dryer will become 85 grains per lb and the leaving condition 28.5 grains, compared with 24 grains in the previous example. In this case, however, we have 800 cfm to deliver to the space so that the hookup is capable of adsorbing a total internal moisture load of 688 grains per min compared with 480 in the previous example.

Another hookup would be to use two 400 cfm dryers in series. In this case, the first stage dryer will handle 400 cfm at 130 grains which will leave at 56.5 grains. If this air is then cooled to 75 deg, keeping the temperature the same level in all examples, the air will leave the

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second stage at 13.5 grains. In this case 400 cfm would be directed to the space and the total internal moisture adsorbing capacity would become 795 grains per min.

It is thus seen that the phrase "stretching dehumidifier performance" is rather a misnomer. It so happens that the capacity curve in the ASHVE Guide which Mr. Franck uses is a reproduction of our own capacity figures. A similar analysis would apply to any other solid adsorbent dehumidifier.

With continuous type solid adsorbent dryers, an allowance should be made for leakage of air across the seals. We recommend that 5 percent of the air dryer capacity be allowed for this purpose. This increases the outside air figure by 5 percent of the air dryer capacity over and above the quantity delivered to the space. This is not allowed for in the calculations.—H. W. HEISTERKAMP, manager, air dryer dept., Bryant Industrial Div., Affiliated Gas Equipment Co., Inc., Cleveland.

SIMPLIFYING SYMBOLS IN ENGINEERING REPORTS

THIS IS A plea for the adoption of symbols suitable for use on a typewriter. The use of Greek letters and other special symbols—and odd positioning and symbol arrangements—just doesn't work out in a busy engineering office. It is true that on the blackboard and in text books the complication mentioned above is not always a disadvantage but the object of engineering procedure is to enable the efficient handling of engineering and laboratory reports in typed, magazine or bulletin form. Such material should be capable of transcription by clerical help simply by copying or from dictation. A valuable engineer hasn't time to go back through a paper, drawing in the symbols, or otherwise working on what should be simple clerical copying.

Consequently, a flexible system for the use of symbols on the ordinary typewriter should be used. This would also fit magazine and printed bulletin requirements and eliminate the trouble they, too, have with symbols. Without claiming originality, I have worked out a method which is practical and for several years now, has shown its value. To use it, only two special symbols are required, a plus sign and an equal sign. It is easy to have these added to any standard typewriter, or lacking them any typist can draw them in. The following paragraphs outline the method I use.

Each paper, report, or article should contain a key to the symbols used. So-called "approved symbols" can cause trouble if the above rule is not followed. For instance, if a symbol for length were used without a key attached, you wouldn't know what unit of length was intended. The first rule, therefore, is to attach a symbol key to each report, and not be too insistent on an approved list of symbols.

The use of subs is changed, the "sub" being placed on a line and directly after the letter. "H sub b" would be written, Hb, or h sub B written hB, or H sub 1, H sub 2, etc., written H1, H2, etc. The rule to follow on this is that numerals and letters without a space between them constitute an algebraic symbol. Thus H b c = x, means H times b times c equals x. On the other hand Hb C = x means, H sub b times C equals x.

Another rule is that where words or initials, such as fpm, are used, put them in parentheses thus: (fpm) A = (cfm). Words and initials can be used to great advantage when a report or other writing is to be read by someone not too familiar with the author's immediate field. To avoid misunderstandings, I feel that everything possible should be shown in formula form, not "H, Btu per hr," but H = (Btu)/(hr). Conversions, too—not "1 ft equals 12 in," but 12 (ft) = (inches).

Another rule is to maintain ample spacing between the individual parts of a formula. This will enable use of full size figures for exponents and will have other advantages not at once apparent.

"Differential t" may be written dt and "delta t" written dt. An integral sign may be a straight line sloping up to the right; it is made by a series of fraction lines found on every typewriter. Other symbols and combinations will occur to the reader. Perhaps lists of suggested symbols would be helpful if issued by the various organizations interested. You will find the suggested method practical. A good way to check would be to try it on your secretary; I'm sure she'll approve.—K.W.

HEAT OUTPUT ON RADIANT JOBS

REFERRING to the article by Paul S. Park in the March issue, entitled Floor Surface Temperature and Heat Output With Radiant Jobs, why not verify claims with actual data developed by proper instrumentation from actual operating conditions?

The fact that a particular installation was calculated to produce 60 to 100 Btu per sq ft of floor area and comfort conditions have apparently been obtained, is no reason to believe that the actual output from the the panel is as high as the calculated value.—D. L. MILLS, research dept., Revere Copper and Brass Inc., Rome, N. Y.

HOW TO CHOOSE ROOF CONSTRUCTION

In the tables published in the Data Sheet on How to Choose Economical Type of Roof Construction, pages 93-95 of the March HPAC, a *C* value of 0.35 for ½ in. gypsum board was given in the heading of the last table on page 94. It is regretted that this is erroneous; the *C* value should have been shown as 2.82, and 0.35 is the reciprocal, or 1/*C*. This mistake of transposition does not affect the values given in the body of the table, however, as the correct value was used in their computation.

Values for 9/16 in. "Fiberglas" are shown in the tables, and it is understood that this thickness of this material is being discontinued.

The 100 percent air conditioned Shamrock hotel—largest in the south—is the central feature of Houston's McCarthy Center

Shamrock Hotel Installation Planned for Houston Climate

EMIL RUSKA, resident engineer for Stone & Webster Engineering Corp., Boston, construction managers for the big new Shamrock hotel opened last month in Houston, describes the interesting innovations incorporated in the air conditioning and heating installation to adapt it to the climate of the coastal plain region of Texas—where winter lingers hardly more than a month of the year and where high humidity prevails. Aim of the highly flexible system is to give the public comfort adapted to the individual's requirements

THE SHAMROCK, the largest hotel in the south, was formally opened to the public on March 17. It is the central feature of the McCarthy Center, Inc., Houston, owned and built by Glenn H. McCarthy of that city.

The structure, which encloses 8,000,000 cu ft, has various shops and administrative rooms on the first and mezzanine floors, the second to the seventh floors inclusive are devoted to hotel rooms for transient guests, and the next six floors are divided into "doublettes," each having a living room with an adjoining kitchenette which is concealed from the living room by disappearing doors. The upper stories of the building are given over to apartments containing two or more bedrooms.

The Shamrock is 100 percent air conditioned and the heating and air conditioning installation includes several interesting innovations to adapt it to the singular climate of the coastal plain region of Texas, where winter lingers hardly more than one month of the year and where very high humidity prevails throughout the year. This imposes an extremely heavy combined heat and moisture load during the summer months, with wet bulb temperatures well into the 80's.

In this day of all-year-'round systems operating for all spaces 24 hr per day, the problem imposed by these conditions was to provide flexible equipment adequate to meet the heavy heat and moisture demands of summer operation and suitable for the small amount of heating required through the mild winter—without causing objectionable drafts at any season.

Three Water Tube Boilers

The boiler plant consists of three integral furnace type, water tube boilers. The steaming rate (maximum continuous) is 26,500 lb per hr per boiler, or a total of 79,500 lb per hr for the three boilers. The fuel burned is natural gas, which

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leaves practically no deposit on the outside surface of the tubes and requires no soot blowing equipment. All walls and the roofs are water cooled, and the floors are ventilated air cooled design, so that the furnace heat releases can be higher than for older style boilers. At rated capacity, the furnace heat release is 33,300 Btu per hr per cu ft of furnace volume.

Each boiler is designed for 160 lb per sq in. ga working pressure with safety valves set for 150 lb operating pressure. The expected boiler efficiency is 77 percent, and the flue gases will leave the boiler at 478 F.

The steam scrubbing equipment, installed in the steam drum of each boiler, is a cyclone steam separator. Baffles force all steam and water mixture to pass through the cyclone separators, which use the centrifugal principle to separate water from the steam. Water, being heavier, is thrown to the outside and downward while the steam rises through the center of each separator. The manufacturer's guarantee states that solids in the steam leaving the boiler will not exceed 3 ppm, if the boiler water concentration is maintained by the operators at or below 3500 ppm.

The setting of each boiler consists of proper thicknesses of first quality firebrick, tile, and high temperature insulating block, held in place by studs welded to the water wall tubes. The outside of the setting is provided with a sheet metal casing to present a neat appearance and protect the insulation.

33 Separate Air Conditioning Systems

The hotel contains 33 separate air conditioning systems, with the guest rooms and apartments being served by four major systems. Each of these four systems serves a different geographical exposure, and supplies an individual unit under each window on that face of the building.

The component parts of this unit are an extended surface coil with a bypass damper and a centrifugal fan. The coil is supplied with either chilled or hot water by the same set of supply and return piping. The fan takes its suction from a plenum into which is drawn air from the outside, air from the room, and basic air delivered through a duct system from central air conditioning units.

The units were especially designed for this installation. Since they had to be small and compact enough to be concealed under the window sills, it was evident that they should not be of the self-contained type and should provide cooling for summer operation by being supplied with chilled water from a concealed circulating system.

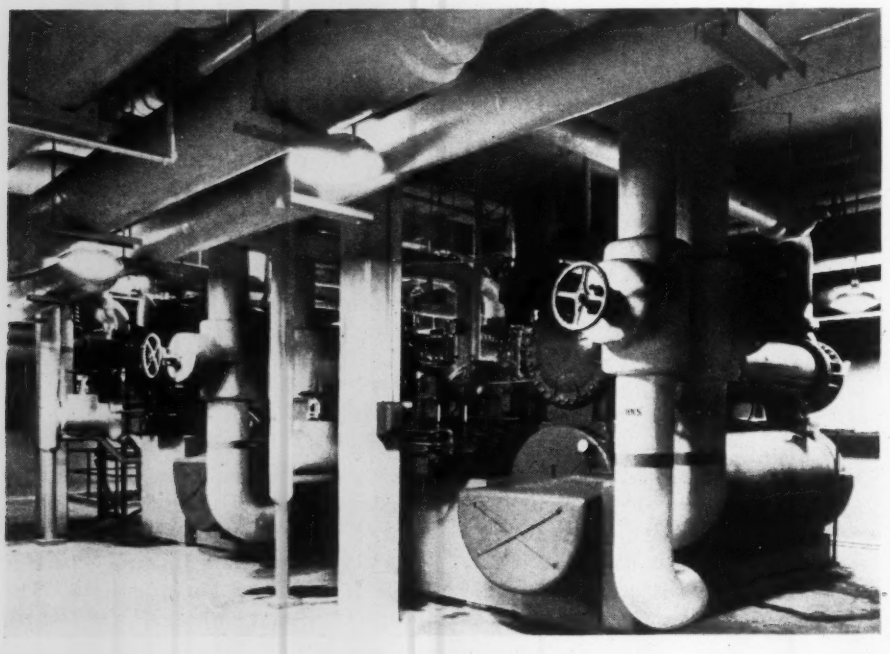
Experience with the prevailing high humidity conditions had shown that some form of reheat was necessary for night and intermediate season operation. Econom[y] is pos[sible] ed to the use of warm air deliver[ed] to each unit through a h[igh] pressure duct system; additio[nal] advantages of this method in[clude] ability to furnish part of the ven[ti]tilating requirement of the spa[ce] and suitability of the air as a hea[t]ing medium on mild winter da[ys]. Due to the drying the air receiv[es] in the basement desiccating pla[nt] the quantity delivered to each u[nit] will assist in reducing the moist[ure] level of the space to the design re[-]quirement under normal outsi[de] weather. The remainder of the ven[ti]tilating requirement of the space is furnished by admitting the required amount of outside air to each u[nit] by means of a long slot placed in a protected position in the overha[ng] of the hollow aluminum window s[ill].

High Pressure Air Is "Super-Dried"

In designing the high pressure air system which serves the u[nits] by means of vertical ducts extending from the basement to the [top] floor, the monetary return on rentable floor space was evaluated against duct size, and it was found to be more economical to install chemical dehydration equipment to "super-dry" the air, and thus deliver less of it through small ducts, than to adhere to the quantities and duct sizes prevalent in usual high pressure systems. The apparent penalty of poor ventilation effected by this small quantity of air is easily overcome by dehydrating the air a proportionately greater amount so that, when mixed with the locally admitted outside air the moisture level of the mixture will be sufficiently below that of the room to be able to regulate the room humidity. Such an arrangement makes possible the bypassing of air around the coil to maintain the desired room dry bulb temperature without the penalty of increasing the humidity.

The unitary type of system installed permits the occupant of the space to select whatever temperature he may desire, yet all utilities serving the system are under the control of the outside weather which regulates air and water temperatures to provide always a certain range of both cooling and heating (so that the occupant may make his own climate). In summer we

The three centrifugal refrigeration machines are driven by steam turbines rated at 840, 387, and 261 hp respectively



ther, these units provide high-grade air conditioning with a relative humidity adjustable down to 40 percent at 80 F dry bulb temperature; in mild winter weather, they function as a warm air heating system; in full winter, they provide hot water heating.

Turbine Driven Centrifugal Machines

In order to cool and dehumidify the air circulated throughout the Shamrock hotel, approximately 1500 tons of mechanical refrigeration capacity—equal to the melting of nearly 3,000,000 lb of ice daily—has been installed. To accomplish this enormous refrigeration effect, three centrifugal refrigeration machines were selected to cool a total of 4065 gpm of water to a temperature of 41 F. To dissipate the heat from the building, 5420 gpm of condenser water is circulated through the condensers of the refrigeration machines and then to the cooling tower on the roof of the garage building, where the water is cooled and returned to the refrigeration machines to be re-used for the same purpose.

The refrigerant used is trichloromonofluromethane, which is odorless, nonirritating, nontoxic, noninflammable, and nonexplosive.

The refrigeration machines are each driven by a turbine which is supplied with high pressure steam and exhausts at a vacuum to provide high efficiency and economy of operation. The turbines have rated capacities of 840, 387, and 261 hp and require a maximum total of 21,600 lb per hr of steam for their operation. In order to utilize most economically the steam generated in the boilers, the turbines are of the extraction type which supply steam after being partially expanded in the turbines at a lower pressure for water heating, etc. As much as 7000 lb per hr of steam may be bled from the turbines at a pressure of 40 lb per sq in. to be used for other useful purposes.

Novel Ventilation Air System

Since cooking is done in the apartments, the ventilation in this building must be exceptionally good. To accomplish this, generous quantities of fresh air are flooded down the corridors and exhausted therefrom.

The apparatus providing these air supplies is novel, in that part of the supply stream is partially dehumidified by passing it through a chilled water coil. This does not dehumidify the air to the required extent, but does lower its temperature to a point which would be unsatisfactory for introduction into the corridors which have no great heat gain. A lesser stream is therefore passed through a lithium chloride desiccator which dries it far below the required level, yet raises its temperature to about 95 F which, again, is unfit for introduction into the corridor.

However, the two streams are mixed before entering the supply fan, and the elevated temperature of the desiccated air raises the low temperature of that from the chilled water coil, while its low humidity adjusts that of the latter stream until both characteristics of the supply air are satisfactory. This results in a great saving of refrigeration tonnage and yet requires but a small desiccator.

Temperature Control for Public Rooms

There are numerous public rooms in the hotel, but by far the largest is the Emerald room—the main dining room—measuring about 105 ft square. It has a dance floor of considerable size from which the tables rise on all sides on terraces of progressive elevation so that all occupants have full view of the floor.

It is well recognized in the air conditioning industry that there is a limit to the control of the temperatures within spaces by means of bypass control on refrigerative types of air conditioning systems, yet that this is an economical means of control. The individual systems serving the public rooms (such as the Emerald room, the Shamrock room, and a host of others) are arranged to permit control of room temperature by means of the bypassing of air around the dehumidifier until this means of control starts to produce an adverse humidity condition. At the very start of this condition, the system changes over to a type of control in which the dry bulb temperature of the space is regulated by the addition of reheat while the moisture removal proceeds as usual or even increases should such be required. These provisions provide a quality of air which, it is felt, has seldom been previously secured in rooms of this nature.

The cleaning of air entering the building and passing through the various air conditioning units is accomplished by three types of filters. Outside air which floods the corridors passes through automatic, self cleaning, viscous coated filters. Air from these corridors forms the supply for the primary apparatus located in the basement, which supplies the 1224 room units with basic air. Before passing through this apparatus, the air is again cleaned by self-cleaning electrostatic air filters in which electrical precipitation is combined with automatic air filtration by a viscous coated traveling curtain of overlapping panels.

The outside air and the recirculated air entering the room units (directly from the outside and the room, respectively) passes through unit type filters which are washable, and provisions have been made to wash and replace these filters on a continuous cycle without interruption of air filtration through these units.

Cleaning of air which passes through the 33 air conditioning units serving various spaces below the third floor is accomplished mainly by automatic self cleaning air filters using viscosine. Some smaller units for this area are provided with unit type filters.

The aim of this somewhat unusual, highly flexible system is to give the public new comfort adaptable to individual requirements, as the position of the bypass dampers in the room units which control temperatures can be adjusted by the occupant without altering the automatic functions of the system as to quantity and quality of air.

Hedrick & Lindsley, of Houston, are the architects and engineers, and Stone & Webster Engineering Corp., Boston, are the construction managers. Donald N. McCord is the project manager for Stone & Webster. The Associated Mechanical Contractors, Houston, installed the heating and air conditioning.

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INDUSTRIAL VENTILATION

Fog Removal in Industrial Plants

ROBERT C. SORONEN, chief engineer, Cloverland Contracting Co., contractors and engineers, Iron River, Mich., describes and illustrates a system involving exhaust fans and unit heaters for supplying tempered make-up air that solved a severe fog problem in a veneer mill. The method could be adaptable to other industries using processes that involve hot rinse tanks or vats.

FOG REMOVAL is a subject as old as industry itself, has long been a perplexing problem to plant operators, ventilating engineers, hygiene and safety engineers, governmental and insurance inspectors—and last (but by no means least) the industrial worker.

This article concerns fog removal in the veneer industry. It is not intended to claim that the method of solution will prove effective in the various other industries, such as foundries, plating, metal cleaning, etc., in which the operations involve the use of hot water tanks or vats.

In the veneer industry, two methods of log preparation are in common use. The first is a steaming process by which the logs, after being cut to the required length (generally 8 ft) are stored in what is termed a "steam chest." As a rule, these chests are independent structures and are usually remote from the manufacturing buildings; therefore, they do not present a problem of fog dispersion and removal.

The second and most widely used method of log preparation, generally found in every veneer mill, is the steam heated hot water vat. These vats average 9 to 10 ft in width and depth, but vary in length depending upon space limitations. Each vat has a loading and an unloading end with a hinged trap door for access to each of these ends. The intermediate area between ends is covered with heavy wood planking.

The method of loading and unloading the soaking vats may vary depending upon space and plant layout, but in the case of long vats it will be found that the loading end is located outside of the building exposed to the atmosphere and to the whims of the elements. The unloading end is always, or almost always, within the bark removal room or the veneer room.

After the logs have been loaded into the vats, they are soaked in 200 to 212 F water for periods ranging from 12 to 24 hr and are then removed for the purpose of peeling the bark and conveyance to the veneer lathes.

The problem of fog removal comes into being as the vat unloading process begins and continues during the peeling or bark removal and until the log has cooled. As the operation is incessant, so too is the problem unless corrective measures are undertaken. The problem can be exemplified by an actual case I was called upon to survey and to offer corrective measures. The system described and illustrated proved to be a 100 percent success in operation.

Fog Problem in a Veneer Mill

This veneer mill encountered its fog condition with the advent of cool fall temperatures and progressively became worse as temperatures dropped to zero and subzero levels, with a gradual lessening in intensity and disappearance with the coming of spring and warm summer temperatures.

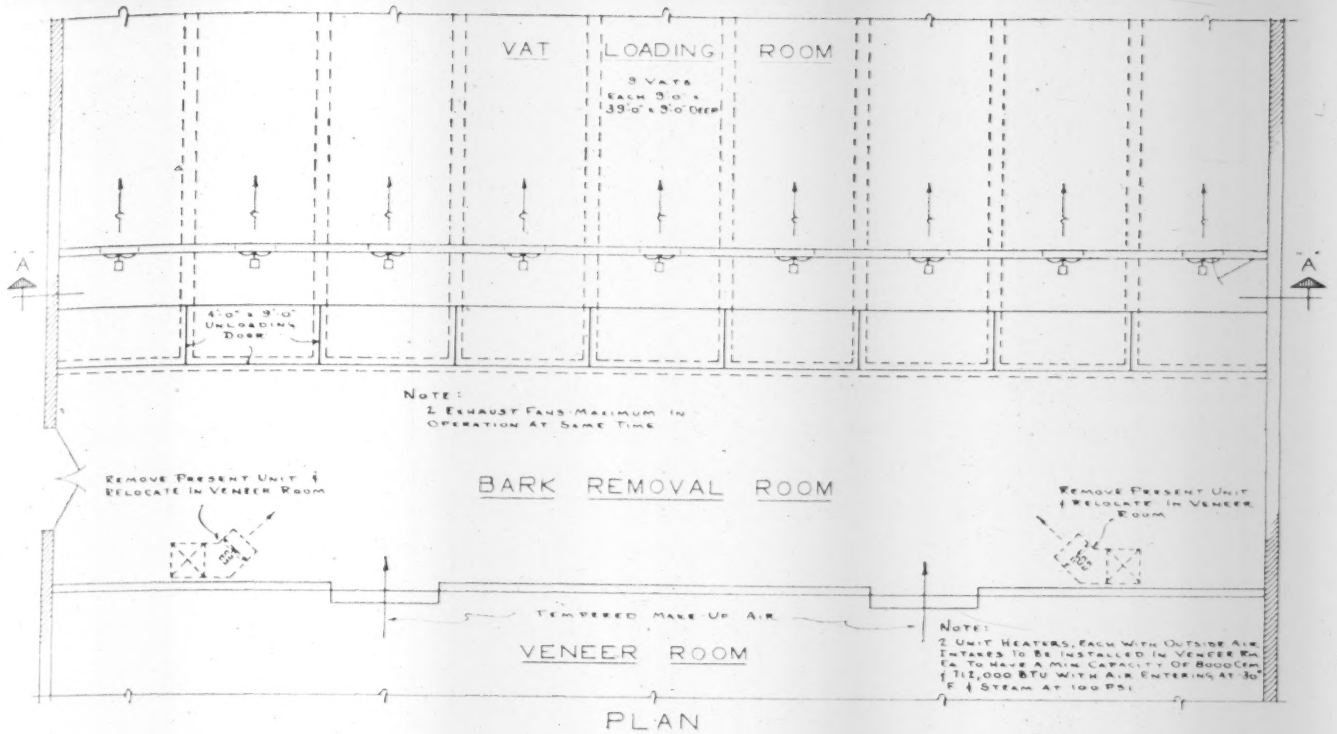
My visit was made in early winter with temperatures in the low 20's. The veneer room was completely enveloped in fog ranging from a density of "fair visibility" at that portion most remote from the bark removal room, to a visibility of "absolute zero" in the area adjacent to the bark removal room.

Men employed in the bark removal room, where the logs are unloaded and peeled, were forced to wear oilskins over their heavy woolens to prevent saturation of their clothing from fog and condensed fog which collected and dripped from the underside of the roof.

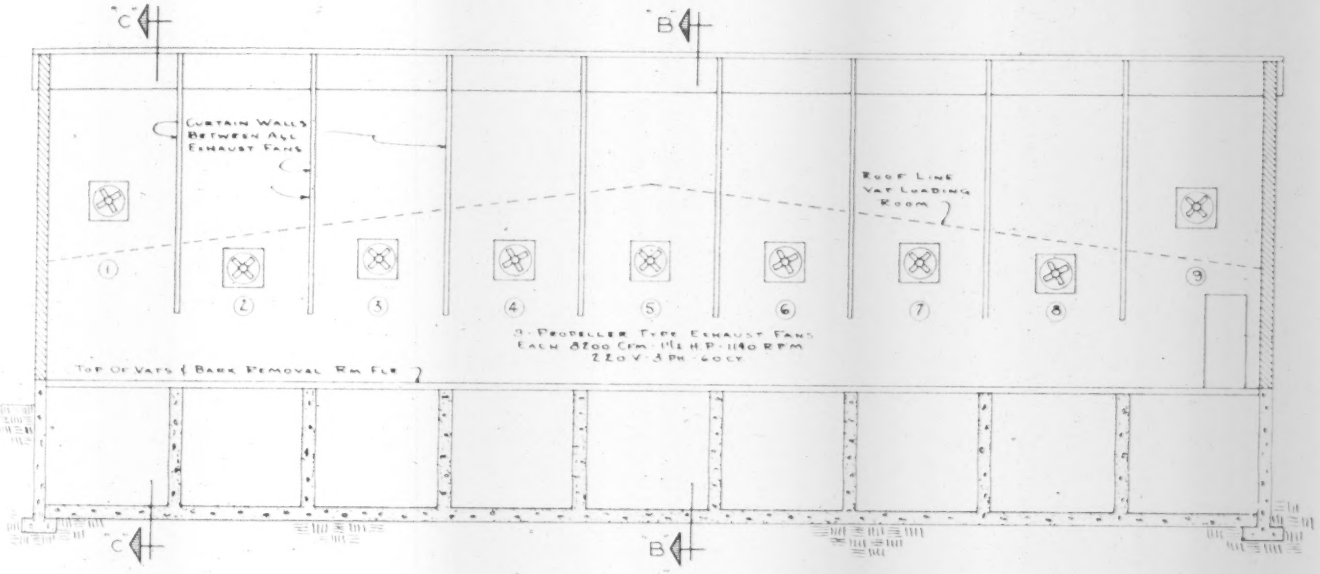
This condition represented a serious problem. It had already resulted in one death caused by a worker falling into an open vat and a serious case of scalding when another worker had fallen into a vat but was pulled out in time. The plant superintendent, a master in the manufacture of veneers but lacking in knowledge of ventilation, had spent hundreds of dollars and countless hours of worry on potential but ineffective measures of fog removal.

Two unit heaters, each with outside air connections to roof mounted goosenecks and with a total combined capacity for delivering 16,000 cfm heated from an entering air temperature of —30 F to a final leaving temperature of approximately 75 F (with 100 psi steam as

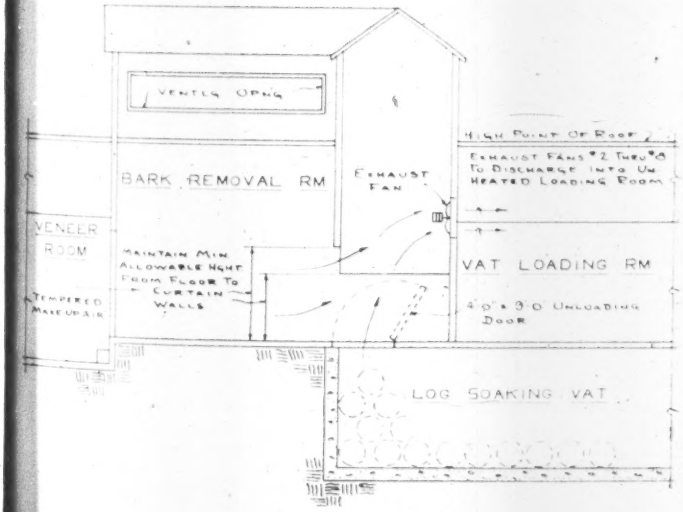
Opposite: Nine exhaust fans, the curtain walls, and two unit heaters for furnishing tempered make-up air as installed at a veneer mill to correct a serious fog problem


VAT LOADING ROOM
3 VATS EACH 9'0" x 39'0" x 9'0" DEEP
A
A
4'0" x 9'0" UNLOADING DOOR
NOTE:
2 EXHAUST FANS MAXIMUM IN OPERATION AT SAME TIME
REMOVE PRESENT UNIT & RELOCATE IN VENEER ROOM
BARK REMOVAL ROOM
REMOVE PRESENT UNIT & RELOCATE IN VENEER ROOM
TEMPERED MAKE UP AIR
VENEER ROOM
NOTE:
2 UNIT HEATERS, EACH WITH OUTSIDE AIR INTAKES, TO BE INSTALLED IN VENEER RM. EA. TO HAVE A MIN. CAPACITY OF 80000 CFM & 712,000 BTU WITH AIR ENTERING AT 30° F & STEAM AT 100 PSI.

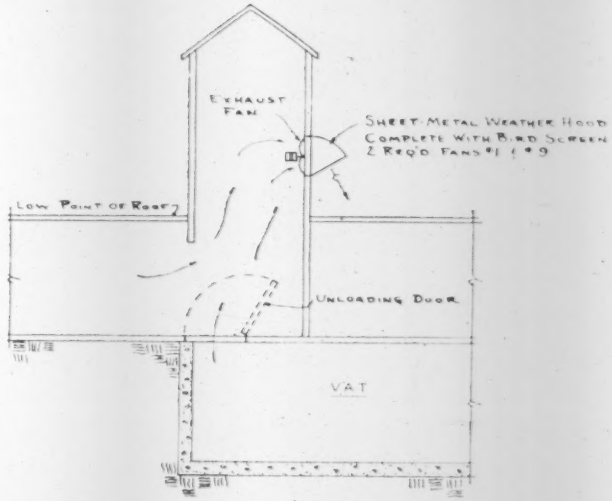
PLAN



LONGITUDINAL SECTION A-A


VENTILG OPNG
HIGH POINT OF ROOF
BARK REMOVAL RM
EXHAUST FAN
EXHAUST FANS #2 THRU #8 TO DISCHARGE INTO UN HEATED LOADING ROOM
VENEER ROOM
MAINTAIN MIN ALLOWABLE HGHT FROM FLOOR TO CURTAIN WALLS
VAT LOADING RM
TEMPERED MAKE UP AIR
4'0" x 9'0" UNLOADING DOOR
LOG SOAKING VAT

SECTION B-B



SECTION C-C

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the heating medium) had been installed in the bark removal room with their discharges directed toward the vats. Each vat was equipped with a 24 in. x 48 in. wood vent stack from the vat surface which terminated above the roof. The stacks had no weather caps or siphon vents. Two 24 in. x 72 in. roof vents were installed directly over the center of the bark removal room.

In addition to a window opening less glass—and two doorways, one to the exterior and the other leading to the unheated vat loading, both less any means of closing—the walls and roof were of such poor and loose construction as to permit the infiltration of an almost unestimable amount of outside air.

For the overall intent and purpose, the vent stacks serving each vat were correctly installed at the source but were much too small in area to be effective. The tempered 16,000 cfm supplied by the unit heaters could not be effectively exhausted through the two 24 in. x 72 in. roof vents.

The sequence and the speed of operations limited the unloading of vats to not more than two at a time. As the unloading process began, the rapidly dispersed steam and vapor from both the opened vat surfaces and the logs was forced by the unit heaters to scatter throughout the entire volume of the bark removal room. As the vapor volume increased, it was in turn forced into the veneer room.

Nine Exhaust Fans Installed

Several systems of corrective exhaust measures were schematically sketched and each was weighed against the other, with the final decision based upon probable effectiveness and installed cost.

The system of exhaust decided upon involves the use of nine 26 in. diameter propeller type exhaust fans, each 1½ hp, 1140 rpm, 220 volt, 3 phase, 60 cycle, 8200 cfm. (see the accompanying plan and longitudinal section "A-A"). Due to the limited clear height, fans Nos. 1 and 9 were furnished with sheet metal weather hoods and were installed to discharge to the atmosphere over the vat loading room roof (see section "A-A" and section "C-C"). Fans Nos. 2 through 8 discharge directly into the unheated vat loading room and thereby assist in increasing the comfort of those employed in this area.

Unit Heaters Temper Make-Up Air

The two unit heaters shown within the bark removal room were removed and relocated in the veneer room at a distance of approximately 50 ft from the wall dividing the two areas and directly in line with the wall openings.

To assist in preventing possible crossdrafts, which would otherwise impair the effectiveness of the exhaust fans, a longitudinal curtain wall constructed of wood planking was erected. In addition, drop curtains or dividing walls, also constructed of wood planking, were erected between each vat to prevent short-circuiting. The longitudinal wall extends the full width of the bark removal room and from the roof line to a distance of 7 ft above the floor line. The dividing walls between vats also extend from the roof line to approximately 5 ft above the vats. The surfaces of the curtain walls and the underside of the wood roof directly overhead were treated with two coats of bitumastic paint.

The exterior or exposed walls of the bark removal room—and the common wall between it and the vat loading room—were sealed with a good grade of heavy roll roofing, doors were well fitted and weatherstripped, and window openings were equipped with new tight-fitting sash. These factors are important in decreasing infiltration to a minimum. All existing gravity vent stacks were removed and the roof openings were sealed closed.

Each exhaust fan has a totally enclosed, drip proof motor. Each motor is controlled by an independent manual across-the-line starter with start and stop pushbuttons in the cover and NEMA type 4 watertight enclosure.

Figuring Cfm of Exhaust Fans

The amount of the exhaust and the size of the fans was determined as follows:

a) Assume 225 cfm exhaust per sq ft of vat surface. (It has been determined by experience that 200 to 250 cfm exhaust per sq ft of vat surface will prove effective under this category of service.)

b) 9 ft × 4 ft = 36 sq ft vat surface area.

c) 36 × 225 cfm = 8100 cfm to be exhausted per vat.

d) Fans were selected with a delivery capacity equal to or slightly greater than the required exhaust requirements and conforming to the specifications stated in the above paragraph.

As previously mentioned, plant operations limit simultaneous vat unloading operations to two. Therefore, this determined a constant exhaust rate of 16,200 cfm. During the heating season, the two unit heaters relocated in the veneer room are in constant operation to supply a total of 16,000 cfm of tempered outside air for make-up.

In conclusion, it appears evident that the system described and illustrated could be adapted or applied to other industries employing the use of hot rinse tanks or vats and is equally adaptable where overhead electric hoist units or monorail systems are in use for mechanical handling of products without interference to the product or the handling system.

Advantages of This System

The advantages of this type of system—to name a few—are:

1) Low initial installed cost due to simple design.

2) Minimum of maintenance.

3) Highly effective exhaust of usually uncontrollable and rapidly dispersing steam and vapors.

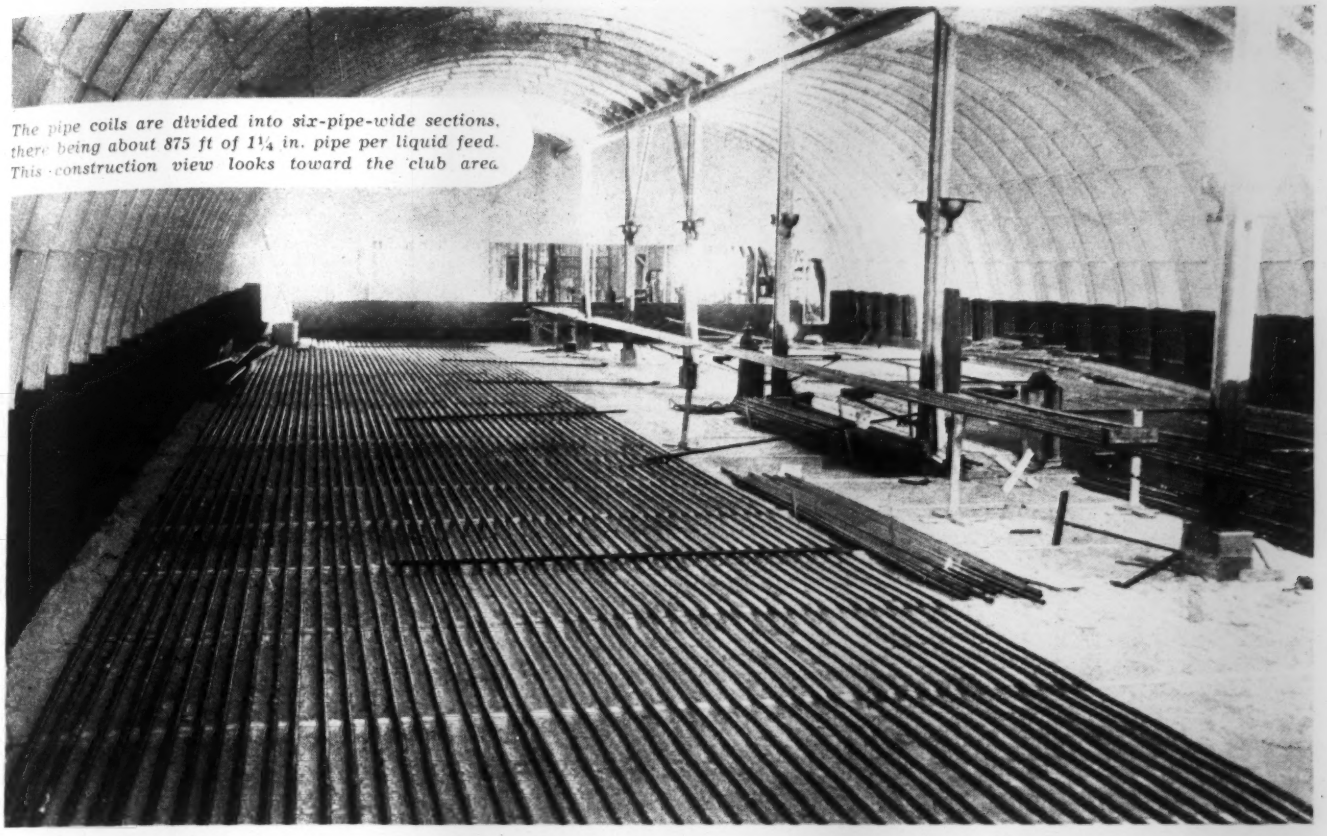
4) Positive secondary air movement within the breathing zone of the operators.

In a future article, I hope to describe and illustrate other simple means of fog removal from tanks and vats as applied to the veneer and other industries.

REPORTS PROFIT AND SALES FOR YEAR

Net profit of Carrier Corp. for the 12 months ended January 31, 1949, was $2,347,896 as compared with $2,286,810 in the preceding similar period.

Completed sales totaled $53,159,620. The comparable figure for the 12 months ended January 31, 1948, was $53,974,774. New orders were booked in the amount of $50,670,071. The total for the preceding 12 months was $45,633,596.



The pipe coils are divided into six-pipe-wide sections, there being about 875 ft of 1¼ in. pipe per liquid feed. This construction view looks toward the club area.

Liquid Ammonia Piping System Freezes Ice at Curling Club

EXCEPT AMONG its enthusiastic followers, the sport of curling is not too well known in the United States. This old ice sport (of Scottish origin) finds its greatest following in Canada; it does, however, have a good number of rabid devotees in the U.S., principally in those northern border states where winter weather lends itself to ice sports.

A curling rink consists of one or more ice strips, or "sheets," approximately 15 ft wide by 140 ft long. Bullseyes painted in the ice, 38 yards center to center, are the targets to which players direct their "stones." The curling stones are polished granite blocks weighing 42 lb, spheroid in shape, and equipped with a gooseneck handle in the top. The game is usually played between two teams, called "rinks," of four players each. Each team is directed by a captain, or "skip," who stations himself at the target toward which the players are shooting and calls the shots for his team. Each player throws ("lays") two stones, with opposing players throwing alternately. The object is for each team to place as many stones as possible closest to the center of the target.

When a curler releases his stone toward the goal, two of his teammates, equipped with brooms, follow the stone down the ice and, at the direction of the skip, vigorously sweep the ice directly in front of and or to one side of the stone to help its speed and direction. Curlers claim that vigorous and effective sweeping can add as much as 15 ft of distance to a shot. The theory back of the sweeping is that enough heat is thereby generated to form a minute water film directly in front of the stone, thus reducing friction and adding distance to the throw.

***ROBERT E. MILLER**, sales engineer, Westerlin & Campbell Co., Chicago, presents the details of the piping and refrigeration facilities for a new curling club having four sheets of ice. The liquid ammonia refrigerant is applied directly to the pipe coils through a liquid ammonia circulating system. There is about 21,000 ft of pipe*

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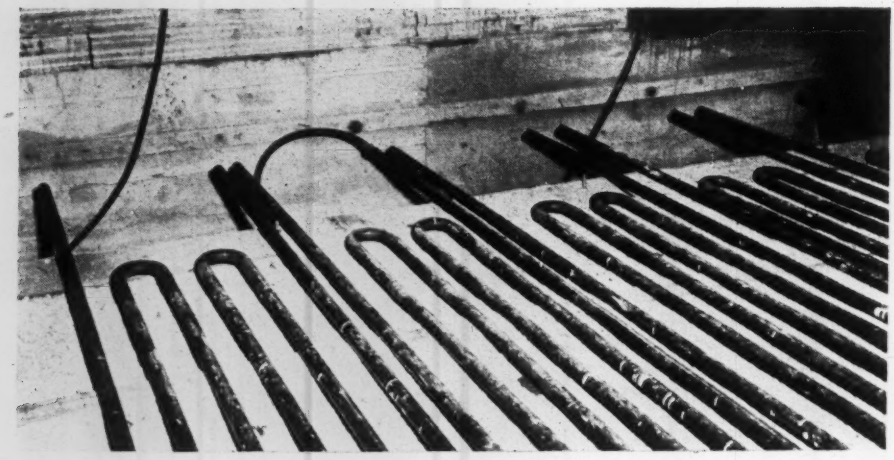
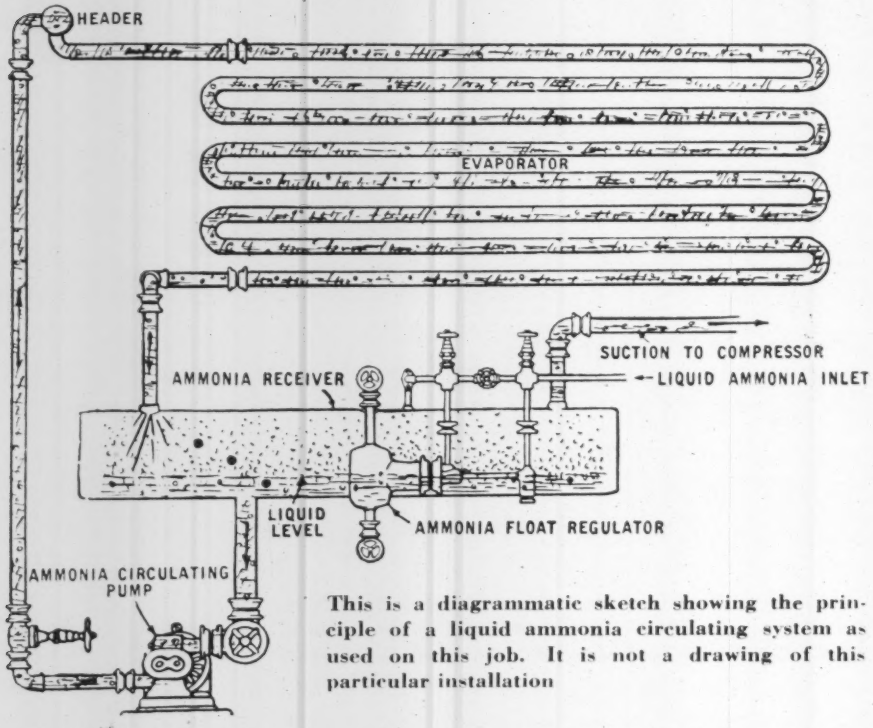


Supply and return headers are in a concrete trench at the engine room end of the building so as to have a minimum run of the interconnecting mains



This is a diagrammatic sketch showing the principle of a liquid ammonia circulating system as used on this job. It is not a drawing of this particular installation

Until last winter, curlers in the Chicago area depended on Mother Nature to produce and maintain their ice. Four country clubs north of Chicago have had outdoor curling rinks since the middle 30's. Too often, this confidence in Mother Nature was misplaced and a match or an exhibition had to be postponed or cancelled.

After 10 or more years of such unpredictable operation, a group of enthusiasts last fall constructed an indoor artificial ice rink in Northbrook, Ill., just north of Chicago. The building, approximately 60 ft wide x 200 ft long, is of double Quonset construction (two Quonsets side by side) and houses four sheets of curling ice. Construction was begun late in September and the building was in use by January 1.

Two Types of Piping for Ice Rinks

There are two general types of refrigeration systems used for ice rinks. The first and more common is the brine rink, where the refrigerant cools an intermediate brine which in turn is circulated through the pipe coils. With the second system the brine circuit is eliminated and the refrigerant is applied directly to the rink coils.

The second system is used at the Chicago Curling Club. Ammonia is the refrigerant and it is applied to the rink coils through an ammonia liquid circulating system.

The principle of this type of refrigerant feed is shown diagrammatically in an accompanying sketch. Essentially, this can be visualized by comparing it to the brine recirculation system in which cold brine is pumped from a brine cooler through piping in the space to be cooled and back again to the brine cooler. With the liquid circulation system, cold liquid refrigerant is pumped in exactly the same way.

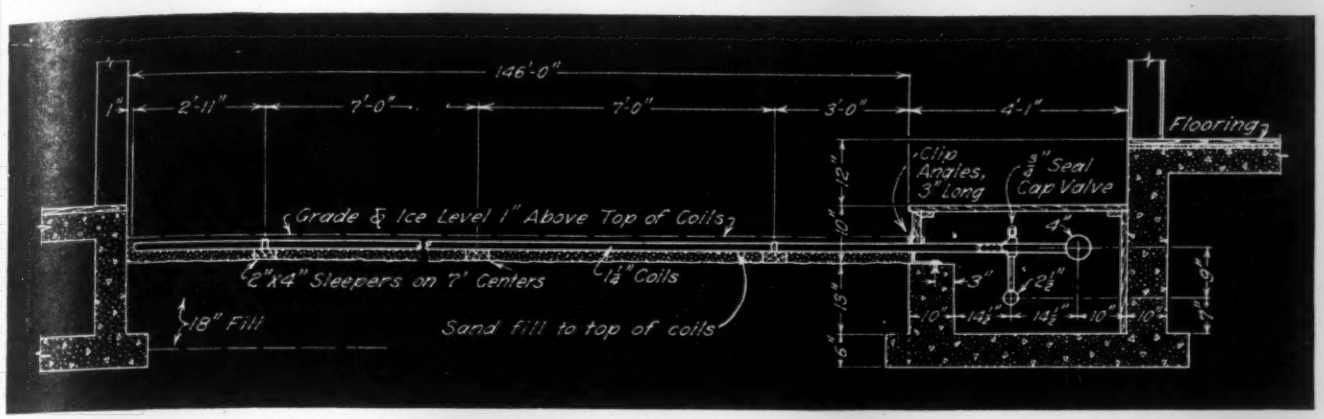
The high side arrangement of the refrigerating systems is typical of conventional systems; the use of the refrigerant recirculating system does not affect high side design.

From the high pressure liquid receiver, the refrigerant is fed into the low pressure receiver, the flow being controlled by a low pressure float which maintains a set liquid level at a rather low elevation in the low pressure shell. The refrigerant is accumulated at the bottom of the low pressure shell as a cold liquid, the temperature of which is governed by the suction pressure being held by the compressor.

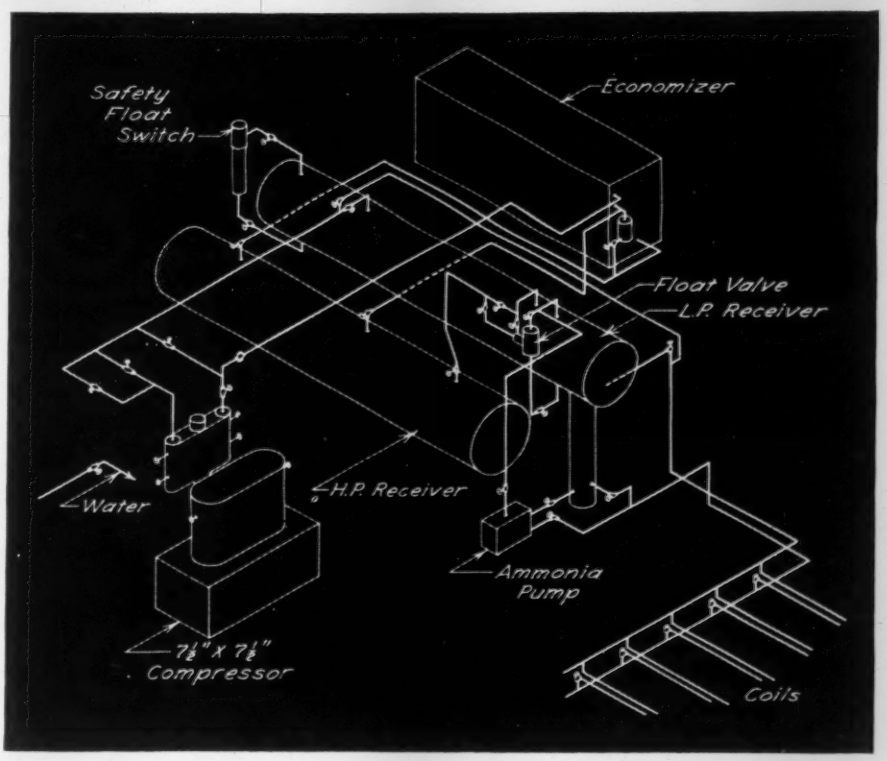
The ammonia liquid pump circulates this cold liquid through the evaporator. The refrigerant is discharged from the pump into the distribution main at from 10 to 20 lb above the plant suction pressure. This pressure head is necessary to force the refrigerant through the distributing mains and through the throttle valves or orifices located at the entrance to each refrigerant pass at the evaporator. These orifices or valves are not expansion valves but are used merely to distribute the liquid uniformly to a number of evaporators or to a number of circuits of one evaporator.

As the liquid refrigerant passes through the evaporator, its temperature remains constant, corresponding to the suction pressure being maintained by the compressor. A portion of the circulated liquid is evaporated as heat is picked up in the evaporator.

Considerably more refrigerant is circulated than is actually evaporated and the mixture of gas and excess liquid flows back to the low pressure receiver. The gas is pumped off by the compressor and the excess liquid falls to the bottom of the



Cross section showing the floor coil and pipe trench construction



Simplified piping diagram of the liquid recirculating system as installed

shell from where it is recirculated.

Although used extensively in general refrigeration applications, this system has not been applied to ice rinks as often as has the older brine system. Yet, where local codes permit direct expansion of the refrigerant in the rink coils, this system has a number of desirable characteristics:

Characteristics of Direct System

1) The temperature throughout the rink coils is practically constant, the only difference being that due to the refrigerant pressure drop through the coil circuits. This is controllable by design, and good design will result in less than 1 F difference between inlet and outlet. This is important in the case of curling, where an even ice temperature is most desirable. Since the only control of the ice surface conditions is by control of the cooling medium, a small temperature range of the cooling medium will result in uniform ice surface conditions.

2) The application of the refrigerant directly to the rink coils eliminates the extra heat transfer stage necessary with the brine cooling system and permits smaller compression equipment for the same effective capacity at the ice rink. For example, to obtain a 16 F brine temperature in the rink coils, the ammonia compression equipment would be required to supply the capacity needed at some 8 to 10 F below this, resulting in larger equipment and greater operating cost.

3) Plant maintenance is reduced since there is little if any corrosive action of the refrigerant on the rink coils and headers.

The refrigerant system as applied at the Chicago installation is shown in the isometric sketch. A 2½ in. ammonia liquid line from the pump discharge supplies the liquid refrigerant to the rink coils. A throttle valve on each piping circuit permits control of the distribution of the liquid. These valves are initially set when the plant is put into operation to feed an equal amount of liquid to each circuit and need not be disturbed thereafter. A 4 in. line returns the gas and excess liquid to the low pressure receiver. The suction pressure control valve in the suction line between the low pressure receiver and the compressor permits regulation of the pressure and, therefore, the temperature of the refrigerant in the low pressure receiver. The refrigerant compressor is automatically controlled from a suction pressure switch.

The refrigerant circuit is equipped with a bypass line from the low pressure receiver to the discharge of the ammonia liquid pump. The low pressure receiver is raised high enough so that there is sufficient head to secure gravity circulation of the refrigerant to the rink coils under light refrigeration loads. Thus, it is necessary to operate the refrigerant pump only when ambient temperatures impose a heavy

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Curlers say that vigorous and effective sweeping of the ice can add as much as 15 ft of distance to a shot

refrigeration load or when the ice is initially being frozen or resurfaced.

The floor is of the usual sand fill construction. After the ground had been excavated and leveled to the proper elevation, a fill of pit run gravel was used to a depth of about 18 in. The gravel was thoroughly rolled and leveled. Sleepers of 2 x 4 Douglas fir on 7 ft centers formed the supports for the rink piping. For the rink piping, 1¼ in. wrought iron pipe was used on an average of 4½ in. centers across the rink, making a total of 144 pipes for the four rinks about 146 ft long, or about 21,000 ft of pipe.

Floor Construction and Coil Layout

The piping runs the long way of the building, with the supply and return headers in a concrete trench at the end of the rink closer to the engine room so as to have a minimum run of interconnecting mains.

In order to keep a reasonable refrigerant pressure drop through the rink piping, the coils were divided into six-pipe-wide sections. Thus, there is a total of about 875 ft of pipe per liquid circuit.

All return bends were shop fabricated and then field welded to straight pipe lengths. After fabrication, each coil section and then the completed assembly was subjected to an air pressure test and all welds were tested for leaks with soap and water. As a final test the entire assembly was given a shot of ammonia and tested with sulphur tapers.

The refrigeration system was operated to freeze the fill before flooding the area when the ice was frozen initially.

The club quarters—comprising a lounge, bar, cloakroom, and toilets—at one end of the building are separated from the ice area by double pane insulating glass. The club quarters are heated by an oil fired forced air furnace, equipped with air filters, and there are two propeller fans in an outside wall for exhaust ventilation. The club part of the structure is insulated with reflective type insulation, over which wallboard was placed.

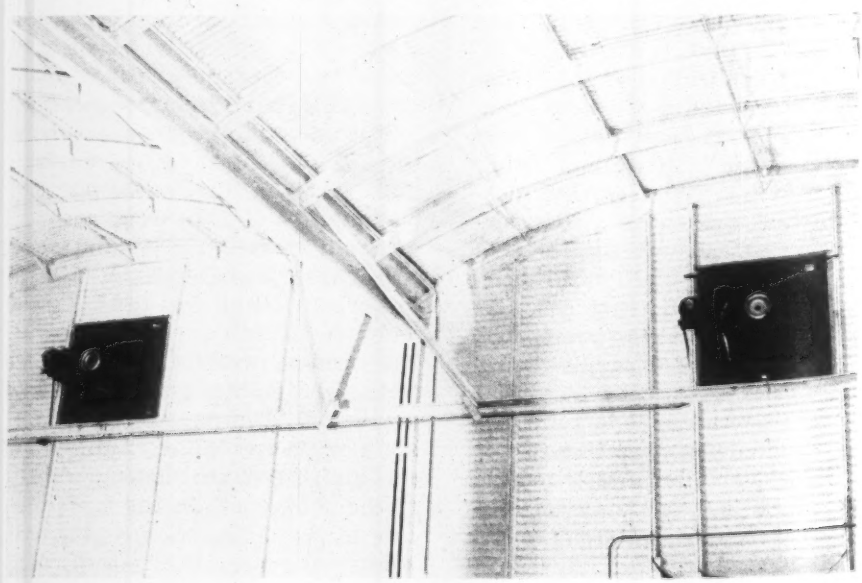
There are also two propeller fans in an outside wall of the ice area to provide exhaust ventilation. It was thought that this might be necessary to avoid condensation on the roof and walls under certain weather conditions. Consideration is being given to insulating the ice area part of the building by the same method as used in the club quarters.

The refrigeration machinery, installed in a 13 ft by 19 ft engine room in the club area, consists of a 7½ x 7½ double cylinder ammonia compressor, v belt driven from a 60 hp induction motor. The compressor is equipped with partial bypass capacity control to permit 50 percent capacity reduction. During normal holding conditions, the compressor operates at 50 percent capacity. When the ice is being frozen initially, or when outside ambient temperatures are unseasonable, the compressor bypass valve is closed and the compressor operates at full capacity.

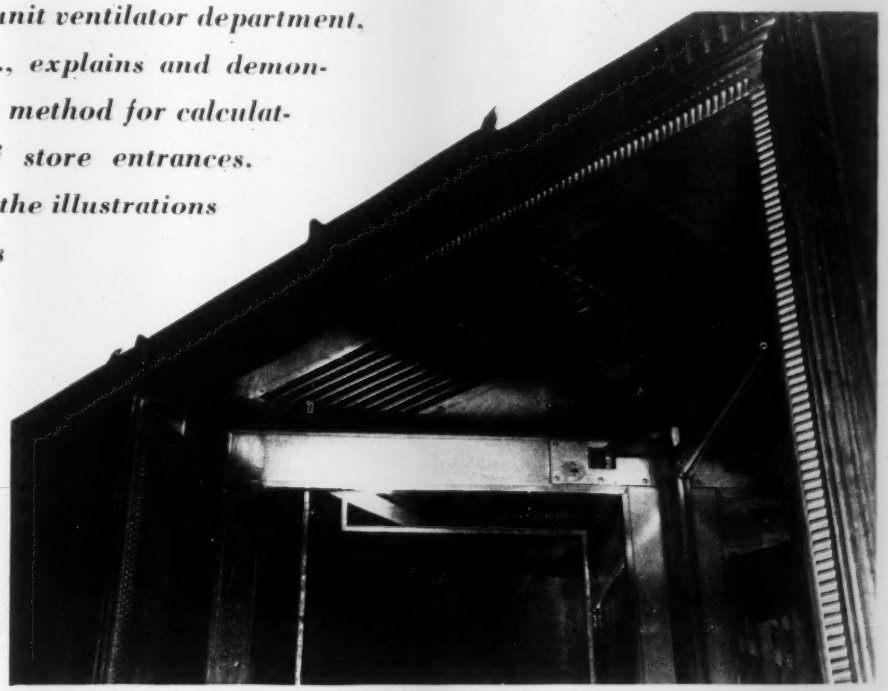
For condensing, an evaporative condenser located outside the building is used. The evaporative condenser is equipped with automatic control devices, so that when outside ambient conditions are below freezing the water is drained from the unit and the condenser operates dry.

Westerlin & Campbell Co., Chicago, were the engineers and contractors for the refrigeration and piping installation, as well as servicing it under a maintenance contract.

Two propeller fans in the ice area and two fans in the club quarters provide exhaust ventilation. An oil fired forced air furnace heats the club quarters



L. R. FULLER, manager of the unit ventilator department, The Trane Co., LaCrosse, Wis., explains and demonstrates in this practical article a method for calculating the heat requirements of store entrances. Tables give pertinent data, and the illustrations show several actual installations



Revolving door entrance served by heating unit through duct work to overhead grille in doorway of specialty shop

How to Figure Heating for STORE ENTRANCES

STOP . . . Look . . . and Listen! That familiar sign at railroad crossings can be applied to store entrances.

The architect designs them to be stoppers—for traffic going by. He makes them the focal point of the building—to attract the attention of everyone. That first impression of a store building is important. Impressions start the instant the customer pulls open the door to the building. Proper entrance heating has a lot do with it.

While there are many ways to heat a store entrance, there is a best way for each particular job. Two store buildings are seldom alike, and seldom is their traffic problem the same.

Building designers are anxious to get people in and out, easily and without confusion. Entrances are designed in accordance with expected traffic, type of building, and location. See data in Table 2.

A Typical Example

Methods of calculating heat requirements for entrances are demonstrated in the following example.

A new bank is being built and the engineer wants to provide the proper heat for the entrance. The design calls for a direct entrance into the main banking room. Outside design temperature is 10 F and the desired interior temperature is 70 F. Using Table 2, the number of passages per occupant per hour is eight. The engineer has been advised that the average number of customers in this bank will be 30. Using eight as the average entrance passages we get 30 × 8 or 240 as the total passages through the doors in one hour. Each of those 240 times the door opened a customer entered or left the building and a large amount of outside air came in at the same time. From Table 1, pick the correct cubic feet of air per passage for direct entrance doors, which in this case is 110 cu ft. In a period of one hour this would amount to 240 × 110 = 26,400 cu ft, or divided by 60 it is 440 cfm.

To do a proper job of entrance heating this cold air has to be (1)

HOW TO DETERMINE INTRODUCED CFM

Use the following formula for determining the correct amount of introduced heated air in entrance heating problems:

$$A_1 = \frac{A_2 \times (T_1 - T_2)}{(LT - T_1)}$$

where: A_1 = Introduced heated air in cfm.
A_2 = Inrushing outside air in cfm.
T_2 = Outside design temperature.
T_1 = Inside design temperature.
LT = Leaving air temperature (140 F or less).

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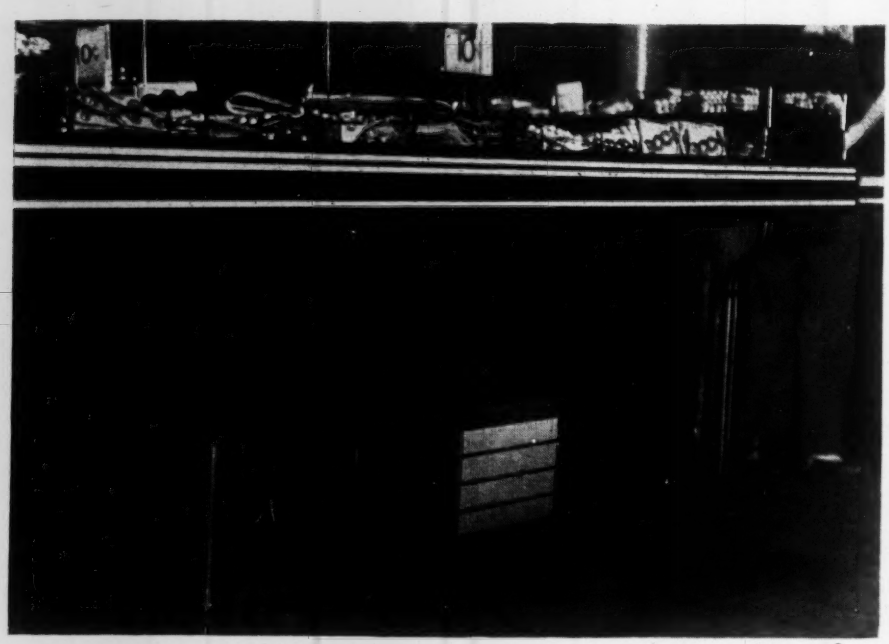


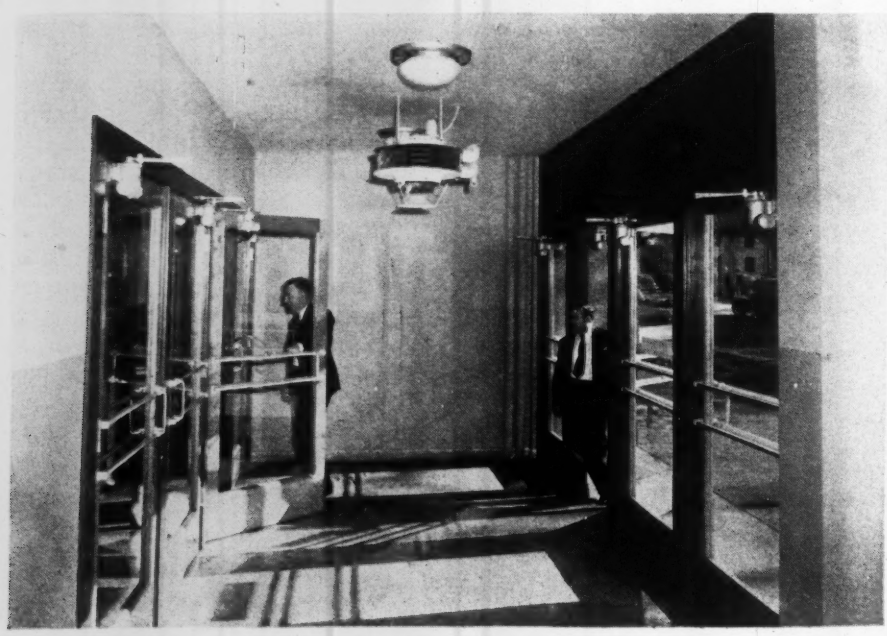
A special heater built into a display fixture solved the entrance heating problem at this variety store

heated to store temperature, or (2) heated air must be introduced to balance the inrushing entrance air.

The general practice used to achieve a final temperature of 70 F at the entrance is to balance the incoming cold air with an *equal amount of heated air,* provided the temperature of the air leaving the heater is not above 140 F. Referring back to the example, it is noted that the entering air is at 10 F and amounts to 440 cfm. In order to heat this entrance air properly, an additional 440 cfm should be introduced at a leaving temperature of 130 F, to give a final temperature of 70 F, in accordance with the accompanying formula, which is given on page 79.

Since leaving temperatures higher than 140 F have an objectionable effect on the incoming customers, it is sometimes necessary to increase the amount of heated air and thus introduce it at a more favorable temperature. Using the same example, but changing the outside design temperature to —20 F, it would be necessary to have a leaving temperature of 160 F if the engineer balanced the inrushing cold air with an equal amount of heated air to get the final temperature of 70 F.

This department store vestibule entrance is heated by a projection unit heater



Because this is objectionable it is better to introduce the air at 130 F leaving temperature, and increase the amount to 660 cfm.

Vestibule Type Entrances

Normally, the designer in temperate climates will provide a vestibule where the entrance heating units may be located. This also cuts the infiltration of outside air by approximately one-quarter. These units should be located so that the warm air will not be released directly at the people entering the building. Outlets for the unit should be pitched to send the air overhead. Floor and wall type units are often used to do the entrance heating job. The grille in the top of the unit directs the heated air in an arc over the heads of the entering customers. Built-in units hidden in the vestibule walls have been used with success. These incorporate a short amount of duct work connecting the unit with an outlet grille at a height of 8 ft or better from the floor. Normally, air for the wall units should be taken from the floor level, but where floor conditions are extremely dusty or muddy at the entrance, inverted units should be used. These units draw in air at the top and discharge it at the floor level.

Ceiling units (such as a projection heater) are also recommended for heating the vestibule type of entrance. They should be mounted 10 ft or more above the floor and some type of diffuser attached to give full coverage of the entrance area. Warm air from the units starts blending with the inrushing cold air above the heads of the customers entering the building, eliminating the possibilities of objectionable air currents.

In both cases the units should be controlled with a thermostat located in the vestibule. In this manner the vestibule may be heated

Table 1—Infiltration through doors (doors in one wall)

Passages per hour up to	Cu ft per passage 1	2	3
300	110	83	30
600	110	82	29
800	110	82	27
1100	109	82	24
1400	109	81	19
1600	108	81	17

1. Direct entrance doors
2. Vestibule entrance
3. Revolving doors (6 ft x 7 ft)

Table 2.—**Entrance passages per occupant per hour for various types of buildings**

Banks	8
Barber shops	4
Brokers' offices	8
Candy and soda	6
Cigars and tobacco	25
5 and 10c stores	12
Dress shops	3
Drug stores	8
Department stores	8
Furriers	3
Lunchrooms	6
Men's shops	4
Office buildings	2
Public buildings	3
Restaurants	3
Shoe stores	4

Note: These figures were determined by surveys on time spent by customers to transact business in each type of building. To find this average time, divide the entrance passages shown into 60.

efficiently regardless of traffic fluctuations.

Store buildings that open up into high ceilinged areas often provide low false ceilings for the vestibule. It is possible to use a projection type unit heater in this installation mounted above the low ceiling and connected to it by duct work. Air is taken from the store interior, heated by the unit and distributed by grilles at the false ceiling end of the duct work in the vestibule.

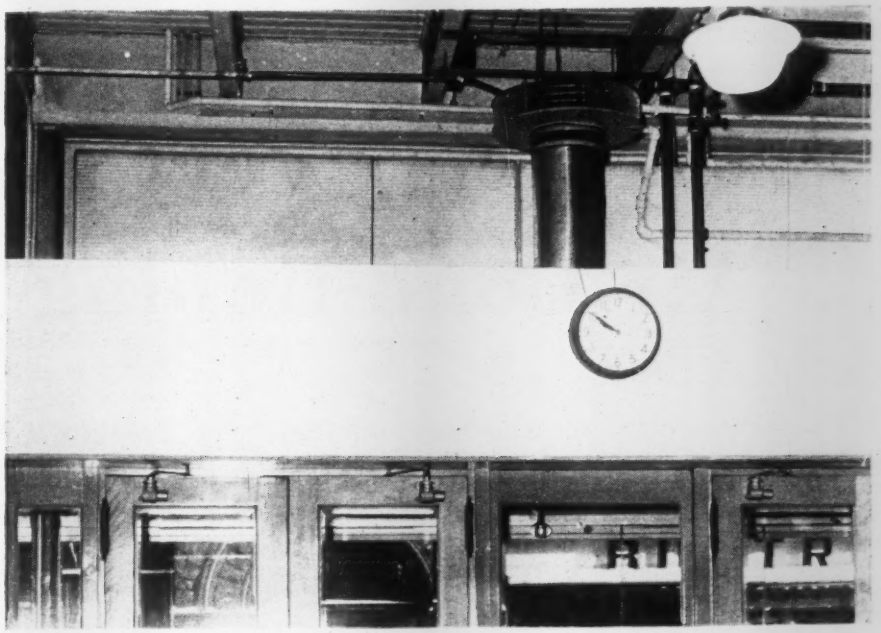
Special Entrance Heating

Some types of buildings—notably variety stores, drug stores, and specialty shops—are often designed with entrances directly off the street, or from deep showcase windows without the use of a vestibule. Here the problem of entrance heating becomes a part of the whole interior heating.

One successful approach to this problem uses a special type of heater built into a display stand fronting the entrance. This unit draws air from behind the counter, heats it, and delivers the warmed air in a diffused pattern around the doors. Another successful method is the application of projection heaters mounted over the doors. These units should be controlled by separate thermostats from the main system since their operation is designed to cover more than straight heating of the interior.

Revolving Door Problem

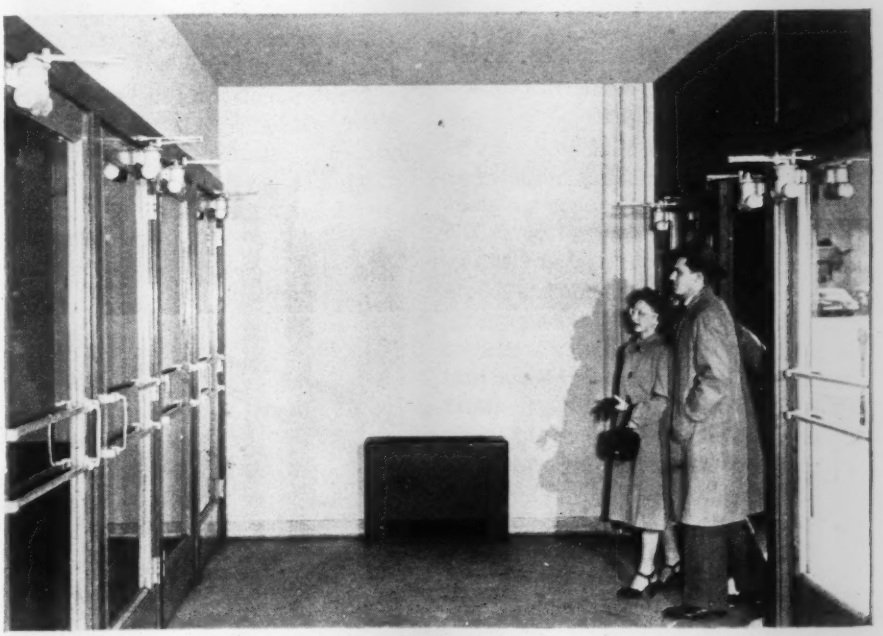
Revolving door entrances offer another problem in entrance heating. With the revolving door the infiltration is cut considerably over the single swinging door, but even so there is a distinct heating problem. Two or more revolving doors are often installed to handle one entrance. In this case it is possible to install a heater over the doors with duct work connecting the unit to one or more of the doors. Air is taken from the interior of the building and delivered through grilles in the ceiling of the revolving door. The grille work is located in the interior quadrant of the revolving door. Thus, the heated air from the units counteracts the infiltration of the outside air at the immediate entrance to the interior.



A short duct connects the unit heater to the vestibule in this case

In many types of buildings where traffic is appreciably slower than found in variety stores, etc., it is possible to handle the heating of the entrance with convector radiators, which do not require forced circulation of air. In this instance the method of handling is to figure the cubic feet of air per hour that infiltrates into the building or vestibule. Multiply this product by 0.018 (the Btu required to raise 1 cu ft of air 1 F) and again by the temperature rise desired to get the total Btu required to handle the entrance heating problem.

An average of eight passages per hour and large occupancy made it necessary to use a high capacity heater for this vestibule entrance



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Predicts "Very Favorable" Air Conditioning Prospect

PETER B. B. ANDREWS, former industrial economic adviser to the War Production Board, explains why the air conditioning industry is given a top "five star rating" by Future Sales Ratings, a service covering 97 leading American industries, for the next 12 months. Few industries have as favorable an outlook both for the near future and longer future, according to the author.

VERY FEW industries in the United States have so clearcut a favorable prospect for both the near future and longer future as does the air conditioning industry. Backlogs of orders in this industry, including potential orders where selling is required to crystallize the desire into an order, is estimated after extensive studies by the author to approximate $7 billion—enough to keep the industry booming far past the next decade.

Considering this prospect, it is not difficult to realize why the rating of five stars is given the air conditioning industry by Future Sales Ratings, nationally known rating service which covers the 97 leading American industries. That is the highest rating any industry can get, and it signifies greater activity in this industry over the next 12 months than in the preceding 12 months.

Future Sales Ratings are prepared by a group of over 100 industrial and government experts, under the author's direction, and the findings are published quarterly in Sales Management.

Tremendous Amount of Modernization

While it is true that the next 12 months for the building industry as a whole are unlikely to be as prosperous as the 12 months past, the air conditioning industry is expected to make a considerably better showing than building as a whole, reflecting the tremendous amount of modernization work and long-suppressed desires of many business executives to equip their plants and office buildings with air conditioning.

Accordingly, the consensus, including government economists and industrial experts, is that the total value of condensing units, compressors, centrifugal refrigeration machines, and self-contained units produced this year will top the $240 million approximate figure for 1948, with a rise to about $275 million. Aside from the natural long-term uptrend in this business, the boom can be credited to widespread expansion and modernization programs, particularly in the retail field, stimulated by pent-up demand for equipment and controls which were not readily available during and after the war.

Many businessmen have known the dollars-and-cents value of having air conditioning installations, obtaining proof from surveys showing business increases ranging from 20 to 40 percent on a year 'round basis when a store is air conditioned in such lines as beauty shops, drug stores, novelty shops, variety stores, restaurants, and hotels.

Thousands of business executives, either employed temporarily in Washington as dollar-a-year men during the war emergency or there for a few days harassedly trying to get materials priorities (I talked to many myself) became solidly sold on air conditioning as they maneuvered about Washington from air conditioned to non-air conditioned buildings, thus emphatically feeling the contrast. Experiences of temporary officers in the armed services likewise highlighted the desirability of air conditioning.

Logical important prospects for air conditioning installations were represented by these executives (particularly in the War Production Board, which controlled every industry) who came from such air conditioning-using industries as candy manufacturing, railroads, drugs and chemicals, printing and lithographing, textiles, tobacco, metal working, food processing, cold storage, building, banks, beauty shops, barber shops, broadcasting studios, clubs, funeral homes, hospitals, hotels, office building management, medical, recreational, department stores, theaters, motion picture production, and many other different lines.

All these (and a number of others) are logical prospects either for original air conditioning installations or for modernization with the improved equipment now available. Technical refinements since the war have increased the efficiency of cooling systems, enhancing their sensitiveness and ruggedness. One company, for example, has developed an electronic air conditioning control system claimed to be 100 times more sensitive than the older types. Many of the prospects in the above industries are unaware of some of these newer developments.

New Construction Important

Aside from modernization projects, expenditures for new construction naturally are very important

At present, it does not appear that total new construction this year will greatly exceed last year's record-breaking total, but total new construction does not have to top the $17⅝ billion figure of last year in order to be considered a good showing.

There is, in fact, almost a feverish activity in some government quarters to get public projects under way, stimulated by the beliefs of some that tendencies to recession would be thus thwarted. The majority, however, continue optimistic on the business outlook and many still talk apprehensively of inflation.

One reason for this apprehension is the tremendous amount of work, either approved or planned, and the competitive impact of such projects on the still fairly tight metals and related supplies situation. A minimum of $5 billion in government, state, and municipal projects (about a billion dollars higher than last year) is the level it is hoped to reach without disturbing the supply picture, which is thought further to be complicated by the rising defense and export material spending.

It must not be forgotten that capital expenditures of states and municipalities also have been long-deferred; moreover, many of these have done financing for various projects and have the cash in hand to proceed. Some of them, frankly, are awaiting lower building costs. That is one reason, the author believes, that the longer term outlook (beyond 1949) will develop much more favorably than the majority of economists now anticipate.

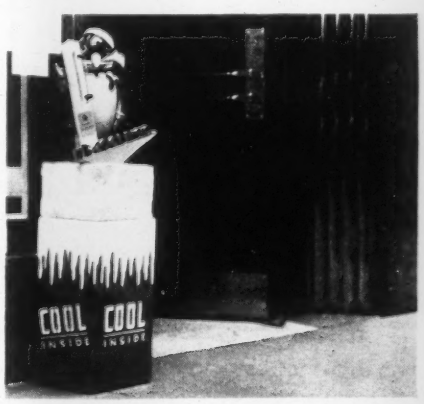
Need for Public Building

There can be no question that the great shifts of population during the war years, together with the nationwide wartime lag in construction, have created a need for expansion of public building that will be strongly felt for years to come. In addition to the obvious projects, spending on which could approximate $5 billion this year, there are hundreds of others that are less talked about, to the end that their crystallization would bring expenditures, the author estimates, averaging about $7½ billion annually for the next several years.

Actually, from all I have been able to glean in my researchings, public works needed now runs well in excess of $100 billion. One group in Washington has its eye on a figure even higher than this as a long-term planning base in a potential drive to smash the peak-and-valley cycle and bring the nation at least some semblance of an even-progressing economy. Many projects have been postponed for years—through the depression and the war—and meanwhile, the country's population has grown enormously, people have risen to a comparatively higher level of prosperity for more of the population, and new urban centers and more geographical problems have been created. This all bodes well for the air conditioning industry; the average government executive is more sold on air conditioning's attractions than the average private industry executive.

With private capital expenditures, the situation differs considerably, both from the viewpoint that some firms expanded about as far as they wish and from the viewpoint that some are just plain scared of Administration policies. In the extremely important private residential construction field, there has been a considerable recent slowdown, reflecting the tightening of financing, some consumer resistance to high prices, and retarding of builders' plans to see what the government will do. It is unlikely that financing will be much easier or that prices will decline much, but as soon as the legislative muddle clears, many plans for residential construction—as well as for industrial plants, commercial, and institutional buildings—will come off the shelf.

Many businessmen know the dollars-and-cents value of air conditioning from surveys showing business increases due to it



Some economic pessimists have been pointing significantly at recent decreases in the rate of savings. This applies, however, only to the *rate* of savings. Even a considerable reduction in the total of the nation's savings would not be alarming, the author believes, in view of the enormous total.

In fact, since the liquid asset position now is bulging distortedly, it could logically be lowered (much of this money has been laid aside to the day when desired things became more available) by $75 billion without cause for concern.

On the basis of such reasoning as the various preceding contentions represent, therefore, does the board of editors of Future Sales Ratings base its decision to give the air conditioning industry a top rating of five stars for the next 12 months. This industry, obviously, will generate tremendous buying power to carry out its numerous and diversified activities.

Numerous Products Are Used

The ramifications of air conditioning equipment, materials and supplies are unusually broad. Completed equipment and installation includes such items as motors, fans, belts, transmission drives, compressors, bearings, various types of hardware, noncorrosive metals, pipe and tubing, a broad variety of valves and fittings, numerous instruments, controls, regulators, humidistats in a wide range, sheet metal, condensers, fittings, couplings, pipe covering, insulation, spray nozzles, pumps, water treatment, metal weatherstrips, refrigeration machinery, ventilators, and dozens of others.

Prospective high activity in the air conditioning industry is bound to have a favorable impact throughout these various fields. In this manner does the board of editors of Future Sales Ratings try to look ahead, after finding conclusively in many years of experience that 99 percent of most statistics are stale. They do not show what we will do; they only show what we have done, and to use them in steering the course of the ship of business is like sending the navigator back to the stern to look at the wake.

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Forced Air System Heats Apartment Hotel Building

FRED G. HAMBURGER, of Guy B. Panero, consulting engineers, New York, describes the forced air heating and ventilating system for a 14 story apartment hotel building in Bogota, Colombia, now under construction. Two unit type steam generators supply the heating coils, laundry, kitchen, unit ventilators, and hot water storage heaters. While the heating load is small, due to the high outdoor design temperature, problems of altitude, fuel availability, water conservation, distance, and language required consideration

THE CAROLINA Vasquez de Ospina apartment hotel building, in the capital city of Bogota, Colombia, which has been designed to provide the finest modern living conditions, is now in process of completion ready for occupancy late this year. The building will be 14 stories high, one of the tallest in Bogota, and of all steel and concrete construction. There will be provided 103 apartments of from two to 10 rooms, plus a penthouse, a 200 seating capacity restaurant, bar, beauty parlor, barber shop, kitchen, laundry, stores, and living quarters for maids and porters. Facilities in general will be equal to the most modern hotels in the United States.

On the mezzanine to the 12th floors inclusive will be the apartments, with the first floor used for lobby, restaurant, kitchen, and stores. Kitchens in apartments will be provided with the latest electric cooking equipment. The basement will include utility services, boiler plant, laundry, restaurant, kitchen storage and refrigeration, and a large water reservoir. Elevator facilities include three modern passenger and one service elevator. The firm of Guy B. Panero, consulting engineers, New York City, was commissioned to design a complete forced air heating and ventilating system, kitchen and laundry, plumbing system, boiler plant, and to prepare specifications in English. The architect is Herrera-Carrizosa-Hermanos, of Bogota.

Though most problems of design and planning were similar to those met in the United States, conditions peculiar to the location were first determined. Bogota is at an approximate elevation of 8400 ft above sea level, affecting air quantity calculations. Basic formulas were revised to account primarily for the change in air density from 1 at zero altitude to 0.730 at 8400 ft, or 13.4 to 18.3 cu ft per lb. This, of course, resulted in increased air volumes. Similar corrections were made for the boiler flue gases. Fans, in turn, which are rated at sea level conditions by the manufacturer, were all selected for the elevation specified and the horsepower and speed revised accordingly.

Climate Is Quite Uniform

The climate of Bogota, which is near the equator and south of the Isthmus of Panama, is surprisingly uniform throughout the year with annual mean dry bulb temperatures of 63.8 F maximum and 50.4 F minimum. Dry bulb extremes vary from 30 to 80 F, while the wet bulb temperature mean varies from 54 to 61 deg.

Data were obtained from a group of three year averages provided by the national observatory of the university in Bogota. As a result, and after consultation with the architect, the design temperatures agreed upon are 70 F inside with 50 F outside. Wind velocities are 18 mph average maximum and 2.5 mph average minimum.

Air is delivered to the spaces at 110 F in the forced air system and at 70 F in spaces ventilated only. The selection of delivered air temperature was based in part on the need for reduced air quantities at greater differentials due to space limitations in corridor hung ceilings.

Selection of a desirable fuel for the boilers was difficult. Since Bogota is almost a week's journey by boat and rail, or by road, from the nearest seaport, and the fuel reserve must be ample, cost becomes secondary to supply, and there is no guarantee of supply for new consumers. Due to space limitations and other considerations, oil was finally selected in place of coal. The oil normally available is similar to United States Grade No. 5. Gas is not available at all for fuel.

The local power company provides a three phase, four wire, 60 cycle, grounded neutral system with 260 volts between phases and 150 volts between phases and neutral. In general, power is provided at 250 or 150 volts single phase or 260 volts, three phase for secondary distribution. Standard 220 volt motors were specified for heating and ventilating equipment with the use

of a bank of service transformers for reduction to 230 volts. Kitchen and heating equipment was specified at 230 to 250 volt standard. Motors over 3 hp were provided with low starting current equipment according to utility regulations.

Water Supply Is Limited

A local problem of importance is the limitation on water supply from the city mains. In dry seasons particularly, this service is for a few hours only in the morning or the afternoon. As a result, a 55,000 gal concrete reservoir is provided in the basement in addition to the usual roof tank. Water temperatures average 52 F with a maximum of 57 F and a minimum of 50 F. Where water supply for refrigeration and other uses is indicated, water economizers or methods are obviously necessary. All recoverable condensate from the steam system is returned to the boiler and the kitchen refrigeration system is provided with air cooled compressors.

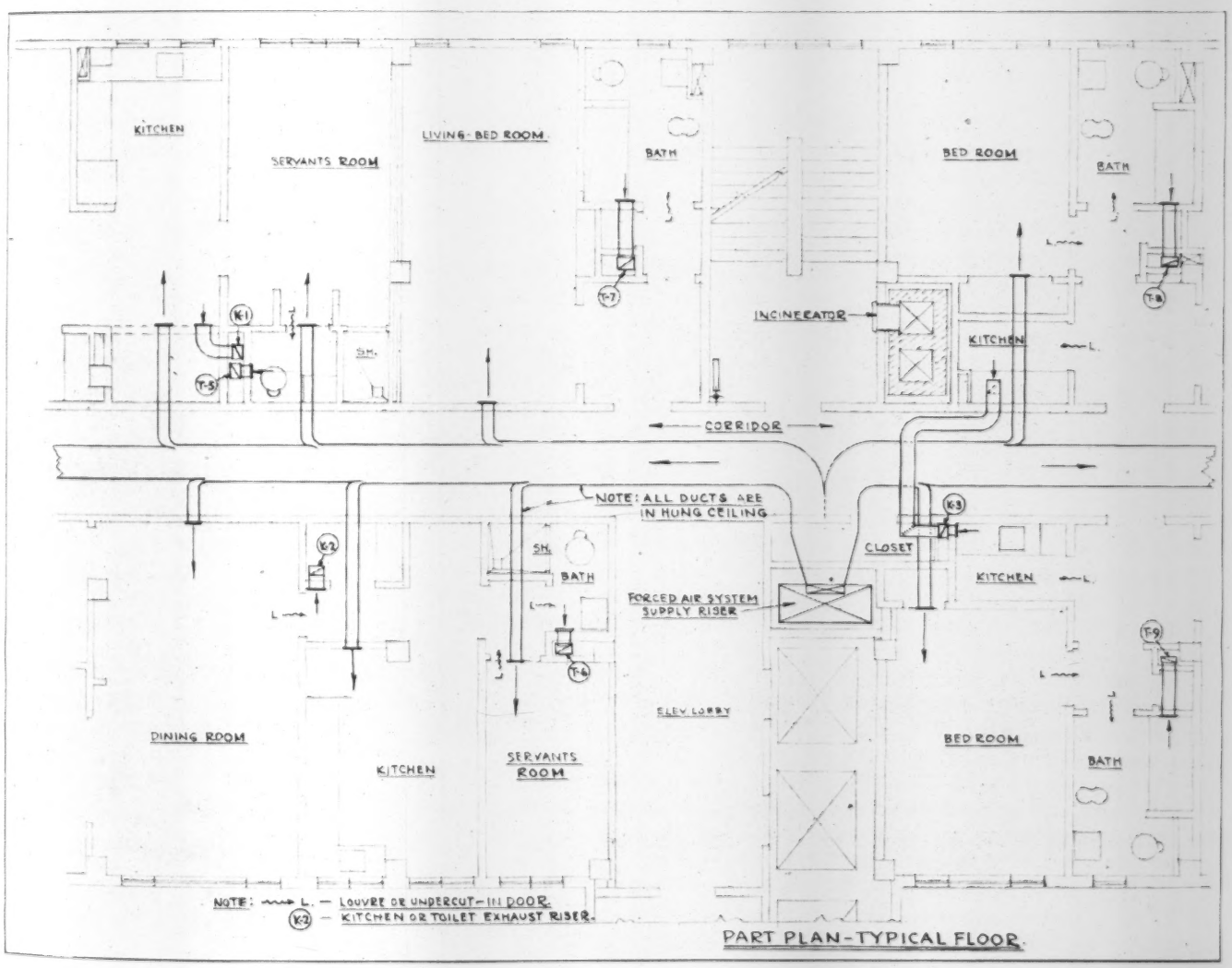
No legal codes govern Bogota for plumbing, ventilation, air conditioning, refrigeration, or boilers. It was, therefore, agreed upon to follow the New York City building code as a guide and minimum for good practice.

The forced air heating system—which was designed primarily for apartments from the mezzanine floor to the penthouse—is of the central type with a single nonoverloading centrifugal supply fan in the basement. The fan is v belt driven and mounted on an integral base antivibration support. Connections between inlet and outlet ductwork and the fan are made with 4 in. minimum asbestos collars. This fan has a capacity of 23,370 cfm at a static pressure of 1½ in. and is provided with a 10 hp, 1750 rpm motor. The use of such a system was decided upon for reasons of economy and because heating loads are relatively light. Heating will be required throughout the year.

At each floor, the take-off splits into two corridor mains, and branches off these mains distribute air to each individual room, with double deflection registers on the walls near the ceiling

Nonfreeze Coils for Uniformity

At the intake side are provided a standard heating coil, filter bank, and louver and screen arrangement with necessary access doors for maintenance. Heating coils are of the copper tube and fin type, are of nonfreeze design (despite minimum temperatures normally above freezing) to obtain uniform heating over the entire coil face. These coils are supplied from the 10 lb steam system. Filters are of the throwaway type arranged in a v pattern to reduce width of the entrance chamber. Air is taken from an areaway at street level. The usual automatic damper at the intake was eliminated since outside temperatures are normally well above the freezing point.



PART PLAN-TYPICAL FLOOR.

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The duct distribution system, which was designed on an equal friction basis of 0.1 in. per 100 ft, has a single main riser from the basement to the penthouse supported at each floor by the framed opening. Take-offs at each floor are made by a throat proportioned in accordance with the ratio of branch volume to riser volume at the take-off and provided with a boot at least 12 in. long. The boot also serves as an acceptable substitute for the usual fire damper at each floor.

The riser is adjacent to the centrally located passenger elevators. At each floor the take-off splits into two corridor mains. Branches off these mains distribute to each individual room, at which point are double deflection registers on the wall near the ceiling.

Small Capacity Registers Required

Care was taken to avoid possible transmission of sound from one apartment to another by careful design of the branch connections. An interesting feature of selection of the registers was the extremely small capacity units required for some rooms due to the relatively low transmission rate, with temperature differentials inside to outside of only 20 F; some manufacturers did not have catalog ratings at these low capacities. Approximately 90 percent of all room registers are only 8 by 4 in. in size.

Each room is provided with a manual damper operated from a wall dial for the occupants' use. These dampers made necessary the provision of an electrically operated static pressure regulator at the supply fan. Major control is provided, however, at the heating coil by means of a thermostat downstream of the coil which controls a modulating steam valve in the supply. The duct thermostat is controlled in turn by an outside compensating thermostat which varies delivered air temperatures with changes in outside conditions. The control is also expected to minimize greatly the use of the manual dampers by the tenants. All thermostatic controls are of the low voltage electric type; an electric system was provided due to the widely separated locations of the supply fans which required local transformers only at these points.

Each Apartment Has Exhaust System

Each apartment has an exhaust system to aid in circulation and to remove kitchen and toilet odors. Stamped steel registers with lock louver boxes are provided in each kitchen and toilet. Exhaust ducts from these systems are collected in 13 toilet and four kitchen exhaust risers, with discharge at the main and penthouse roofs.

Since the main roof is used also as a terrace for the penthouse apartment, it was found desirable to so route these risers that much of this roof space would still be useful for that purpose, present a pleasant appearance, and keep the exhaust discharge a satisfactory distance from the penthouse to dispel possible odors. Roof exhaust fans for this purpose are the fully housed type, all copper, with down discharge and equipped with variable speed pulleys. Toilet exhaust on the basement, 1st floor, and mezzanine floor is also tied onto these fans. Control of all fans is from the basement.

Exhaust ventilation only is provided for the basement general area and the laundry by means of an exhaust fan in a fan room on the main roof. A single riser runs from the basement and is located in an enclosed shaft with the kitchen exhaust riser. Ductwork from the laundry to the fan is of copper, though other branches on the same system are of galvanized iron. Connections between the copper and iron are made with asbestos collars. Filters are provided for the air entry into the laundry only, which is from a street level area.

A similar exhaust system is provided for the kitchen and exhausts over the range hoods, bakers' table, steamers, and dishwashers. The kitchen exhaust fan is similar to the laundry fan with air cooled bearings outside the casing, and it is located in the same fan room. This fan is provided with a fire damper at the discharge which bypasses the air for protection of the fan in case of range fires.

The kitchen duct system from the range hood to the fan is made of No. 10 ga black steel and the riser in the enclosed shaft as well as the fan is insulated with 2 in. 85 percent magnesia blocks. Ducts from the dishwashers are made of copper and are pitched back to the washers. The foot of both kitchen and laundry risers is provided with a pocket and drain for possible condensed moisture in the risers. Both kitchen and laundry areas are designed for exhaust at not less than 20 changes per hour with the air for the kitchen provided by exhaust from the restaurant ventilation system.

Horizontal Unit Conditioners

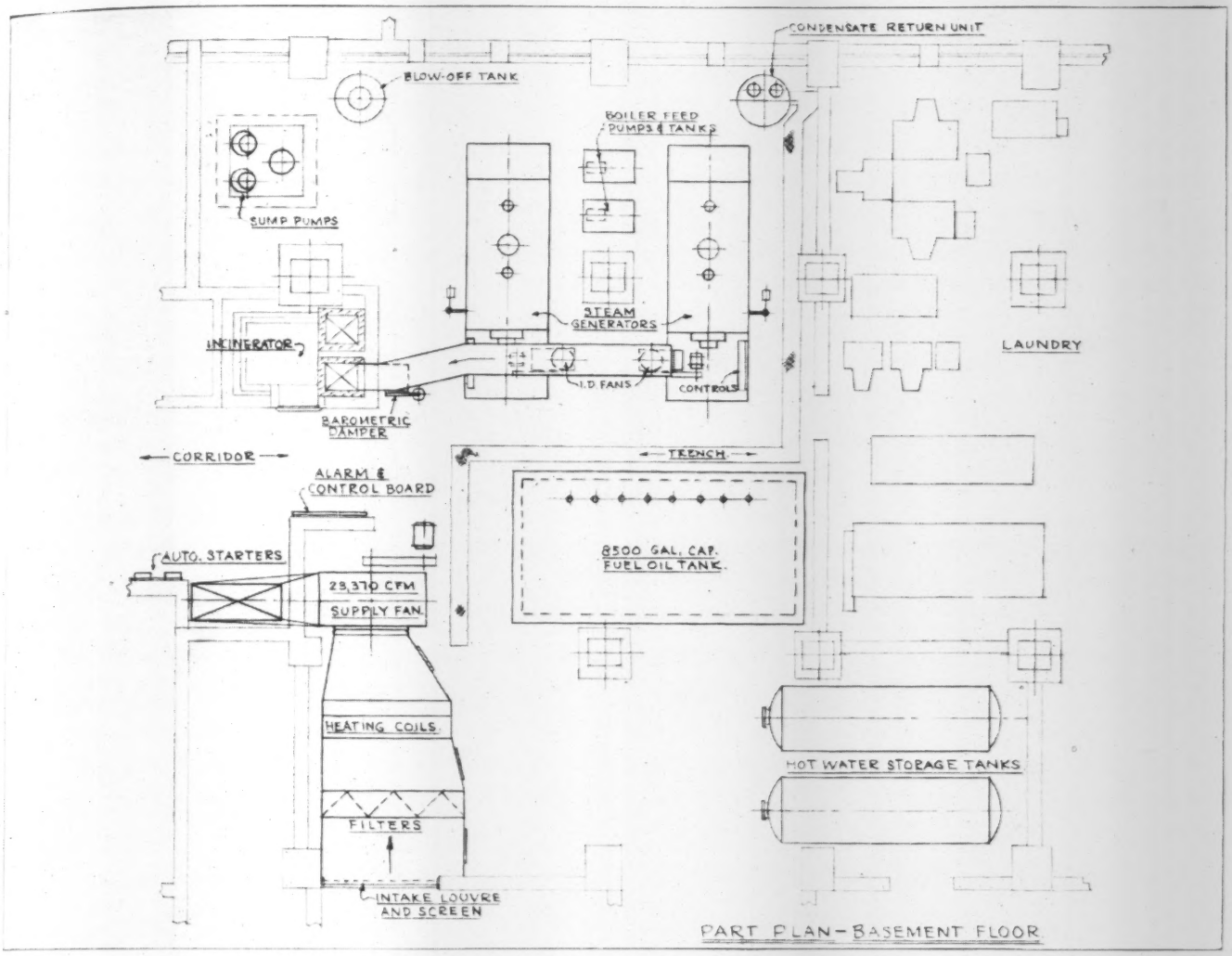
Separate supply and exhaust ventilation systems are provided for the first floor restaurant and the mezzanine barber shop and beauty parlor. Standard horizontal type unit conditioners with fan section and fan, heating coils, and throwaway filters are located adjacent to the areas served and provided with modulating type steam control valves.

The restaurant ventilating unit is located at the kitchen ceiling and supplies air at 70 F through a distribution system in the hung ceiling over the restaurant dining and dance floor areas. Ceiling diffusers are used throughout, including units in the raised bandstand. The air is exhausted into the kitchen system through a waiters' passage behind the bandstand and a return air grille in the wall between the kitchen and the restaurant. Air quantities of approximately eight changes per hour in the restaurant equal the desired exhaust from the kitchen system.

The beauty parlor and barber shop system is similar to that for the restaurant but with the addition of a mezzanine roof exhaust fan for the beauty parlor. This system is designed to provide approximately 12 changes per hour and provision is made to exhaust over the permanent wave machine areas. Both the beauty parlor and the restaurant systems can be quickly converted for air conditioning in the future by the addition of a cooling coil section to the conditioners. A smoke exhaust fan is also located in this area for the first floor bar and is on the mezzanine roof adjacent to the other exhaust fans in this area.

Alarm and Control System for Fans

A feature of all fans for the entire building is the alarm and con-



trol system. All supply air fans are provided with fire thermostats to shut off the automatic starter. All supply and exhaust fans are also provided with fan alarms on a board located in the basement near the operating engineer's station. Pilot lights and an alarm bell signal the failure of any fan to function. On this board are also located alarms for two steam pressure reducing stations, high and low level alarms for the roof gravity tank and the reservoir, and a high water level alarm for each of the sump tanks in the basement.

Steam Generators of Unit Type

The boiler plant, in the basement, consists of two high pressure steam generators of the unit type so widely used today. With a headroom available of only 10 ft (the basement and first floor concrete slabs were already poured well before engineering plans were completed) and a new pit in the floor economically undesirable, the advantages

The boiler plant consists of two high pressure steam generators of the unit type. Available headroom is but 10 ft

of this type of low headroom boiler are apparent. They have the further advantages of quick starting, completely automatic pushbutton operation, and can be shipped crated in one piece for simple erection on the floor, all of which were considered of prime importance for this installation. The use of oil for fuel also provides flexibility for varying loads and the simplicity of operation necessary to the engineer.

The boilers selected each have a maximum capacity of 2760 lb per hr (approximately 50 percent of full load) at 100 lb ga pressure and are guaranteed to provide minimum 80 percent thermal efficiency at full load. They are of the all steel, four pass, horizontal Scotch marine, fire tube type, and are completely equipped with structural steel base, oil burners and dual pumps, heaters, safety and operating controls, and induced draft high temperature fans.

The burner controls are designed to provide good combustion over a range from 35 to 100 percent of the firing rate. The boilers and fans were specified, of course, for operation at 8400 ft altitude.

Boiler make-up water, estimated up to 25 percent, from the city mains, based on chemical analysis, is soft and slightly alkaline. Treatment recommended is a dry chemical phosphate base powder which is fed manually at specified intervals to the system via the condensate return tank.

Ignition by Bottled Gas

Ignition is tentatively planned by means of bottled gas (supplied from a battery of three bottles) which is available in Bogota from two sources. However, alternate means are provided for using light oils (such as No. 2 U.S. grade, kerosene, or diesel) fed by gravity from a 275 gal overhead tank.

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Owing to space limitations, an 8500 gal capacity rectangular tank will be located in the boiler room. Since this represents only a 10 days to two weeks fuel supply, recommendations have been made to provide more capacity elsewhere in the basement area. The tank, which is of New York City code construction, will be fire protected by a 6 in. reinforced concrete casing on top and sides. The fuel oil used is not required to be preheated in the tank.

Flue gases are discharged above the penthouse roof in a firebrick lined stack located in a central insulated shaft with a separate incinerator stack. This stack was amply sized and corrected for elevation, and a barometric damper was provided at the foot of the stack. Both flue gas and incinerator stacks were designed to conform to the New York City code.

The steam is supplied to the various points in the building at approximately 100 lb to the laundry, 25 lb to the kitchen, and 10 lb to the unit ventilators, forced air system, and hot water storage heaters. Reducing valves are of the single seated, dead end type, spring loaded, and are located in the boiler room for convenience of the engineer. All points of steam usage are individually trapped and returned entirely by gravity to a condensate return pump and tank unit in the boiler room floor. This unit is a standard duplex type with a cast iron tank and is vented to the roof. Careful routing of the return lines limited trenching to a single run in the boiler room floor.

Condensate from the return tank is pumped to two combination boiler feed tanks and two stage hot water pumps furnished with the boilers. These units are interconnected and provided with equalizers and overflow connections to the sump pit. Each pump is sized for one boiler only and is controlled by the boiler water level controller. These tanks are also vented to the roof.

A cylindrical boiler blowoff tank, 3 ft in diameter by 4 ft long, was recommended for this installation. This tank is located at the boiler room ceiling and discharges to the sump pit. It is provided with a cold water connection for temperature reduction and all necessary drains to prevent water hammer during its use.

The design of all the mechanical systems (as well as the selection of equipment, including the kitchens and laundry) was made with the knowledge that contact with the job is difficult because of distance and, to some extent, language barriers.

It is important, therefore, that full and clear information be provided in both specifications and drawings.

The intricate hookup and special knowledge required of kitchen and laundry equipment and layout emphasizes the usefulness of the consulting engineer for such installations. Equipment should be shipped assembled where possible, ready for quick and simple erection.

Call It Radiant or Panel Heating?

IN READING recent articles in HPAC, I am again reminded about a point that has come to my mind from time to time in connection with panel heating. This may be a minor point, but nevertheless it has occurred to me that the term "radiant heating" is used when really it should be called "panel heating." It seems that "radiant heating" is used more than the term panel heating in the field of the nontechnical man as well as in the field of the heating engineer. Yet when reference is made to the ASHVE Guide for 1948, the chapter on Panel Heating and Radiant Heating, page 565, states:

"It is convenient to distinguish two different methods of introducing radiant heat into an enclosed space. The first which may be called high temperature radiation, involves direct exposure of the occupied parts of the room to radiation emitted from relatively small heating units of very high temperatures (perhaps 1000 F); the second, panel heating involves exposure to relatively large surfaces at not over 130 F.

"High temperature radiant heating may be useful for temporary purposes, as in the use of a bathroom heater. It is, however, generally an undesirable process (except in rooms of great height) on account of the marked unevenness of the effect produced on the human body. Studies at the John B. Pierce Laboratory of Hygiene have shown that this type of heating produces uncomfortable differences in the temperature of different parts of the body (an overheated head, for example, if the heat comes from the ceiling).

"Panel heating, on the other hand, is advantageous from the standpoint of temperature differentials. In actual practice, a well-designed system of this sort produces very uniform conditions, the air throughout the room differing at various points by only 5 deg. This is desirable from the comfort standpoint and may also be a factor in heat economy, since high temperature in the upper part of the room favors excessive heat loss."

Now surely the proponents of the panel heating system will not allow the above statements about the radiant heating system to be applied to the panel heating system, because it would be a very obvious distortion of facts. It appears that some distinction should be made between the two types of systems, and it seems to me that the heating engineer should be the leader in getting this matter clarified. Unless the heating engineer is careful to use the correct terms with reference to this popular type of heating, confusion will more than likely increase in the minds of engineers, architects, contractors, and owners. Since your publication is widely read by authorities as well as others, it seemed logical to me that this might well be the sifting medium by which the heating profession could be educated. — ROBERT W. ROOSE, special research associate in mechanical engineering, University of Illinois, Urbana.

Test Special Fills for

HEAT PUMP GROUND COILS

S. L. PAPPAS and C. R. FREBERG, of the Southern Research Institute, Birmingham, point out that various substances have been suggested from time to time as a means of improving the contact between pipes buried in the ground and the ground, as used with heat pump installations utilizing the ground as a heat source and sink. This would have the effect of improving the heat transfer for a given length of pipe, particularly when heat is being dissipated. It was therefore decided to make accelerated tests on several mixes of bentonite, silica gel, and other hygroscopic materials to determine whether or not there were any cracks formed. If not, it can be assumed that the material has good possibilities. Nine mixes were tested over a period of several weeks. Most mixes involving bentonite appeared to be of little value because they developed large cracks. However, as a result of the tests, there appeared to be three good possibilities: (1) plain sand, (2) sand with a small amount of silica gel to attract moisture, and (3) sand mixed with bentonite and oil

WHEN PIPES are used with heat pumps to pick up and dissipate heat from the ground, it is desirable from a cost standpoint to use as little pipe as necessary. The amount of pipe needed depends largely on the heat transfer obtained per foot of pipe. Therefore, it is desirable to provide the best possible conditions for heat transfer. This has been one of the problems the Southeastern Electric Exchange has been interested in and sponsoring for several years.

One method often suggested is that of using special fill materials which will insure contact at all times. From the available data, it appears that the heat transfer depends on conduction and moisture migration. The conduction is not only a function of the soil material but also the moisture content. When the coil is cold, moisture is attracted toward it and effectively increases the heat transfer. On the other hand when the coil is hot, the moisture is driven away. Initially this is all right, but soon the soil in the immediate vicinity of the coil is dried out and often shrinks away from the coil. This air space acts as an insulator and the heat transfer is reduced very substantially.

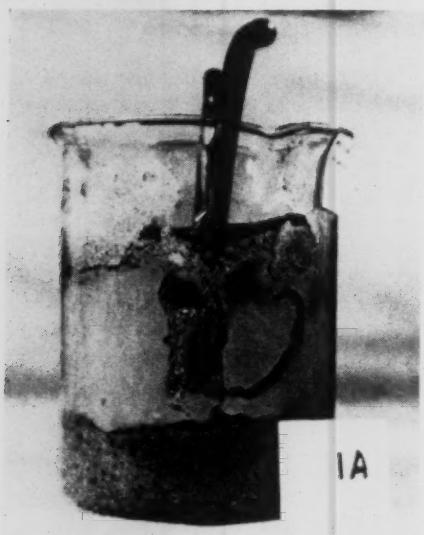
The contact may be maintained in two ways: A soaking system can be installed or a fill material may be used which will maintain contact. Bentonite (bentonite clay or Wyoming bentonite) has been mentioned as a good possibility for use as a fill material. It is a colloidal clay used as an inert filler in various chemical and ceramic products. It expands 10 to 13 times its dry size when mixed with water until it becomes a thin paste. When dried, it shrinks into a hard, dense lump. It is used in oil well drilling to seal up small leaks as well as form a suspension which will carry drilled particles from the bottom as it is circulated. It is also used in the bottoms of large fish ponds and behind dams to plug the leaks. When mixed with oil it expands very little. Hygroscopic materials such as silica gel and calcium chloride have not received very much attention as fill materials but should offer good possibilities.

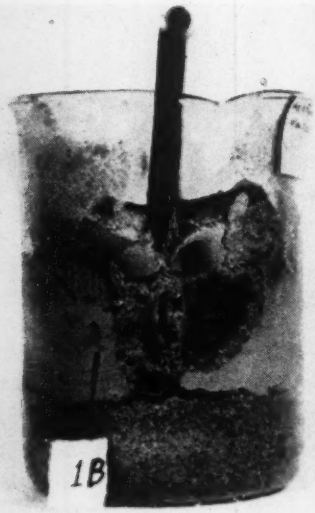
Nine Samples Tested

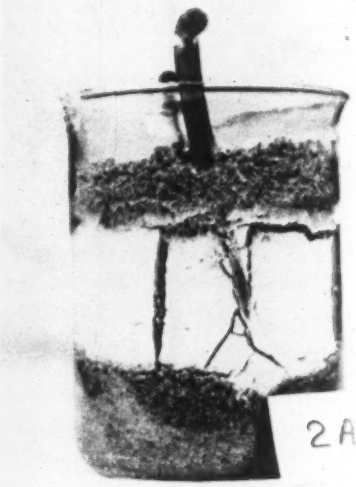
Before using any of these materials, it seemed wise to run a series of accelerated evaluation tests which would show whether there were any cracks formed when the pipes were heated. These tests were intended in no way to show the relative heat transfer but only the tendency to crack. However, it seems reasonable to assume any test showing cracks around the pipe would have a greatly lowered heat transfer rate.

Nine samples were prepared and subjected to an identical test. A 400 ml beaker was fitted with a copper U tube bent so that the two sides touched the sides of the beaker. The beaker was then one-fourth filled with sand. On this bed of sand, about one-third beaker of the test mix was poured followed with about one-fourth beaker of sand. The sand was used to allow moisture to move more freely into or out of the mixture. With this set-up the action of the mixture around the tube could be observed as hot water was circulated through the tube. The tubes were all connected in series and the water entered at about 120 F and left at about 114 F. Pictures were taken at the start of the test and at weekly intervals thereafter. Daily observations were also made.

The tests were run only with hot water because it was felt that this would be the critical condition. If contact with a hot pipe was maintained, it would be quite likely that contact with a cold pipe, where the moisture tends to flow toward the pipe, would be maintained. Only full scale installations will evaluate the heat transfer characteristics and determine whether or not it is







Figs. 1a and 1b—Sample No. 1: 12 percent bentonite (by weight), 88 percent water—This mixture formed a thin paste which was quite able to flow. The sample started cracking within 24 hr and Fig. 1a shows the result one week later, while Fig. 1b shows it two weeks later. The top layer of sand has sifted down into the large cracks. If ordinary soil had been used, it is quite probable that large air spaces would have formed, thus reducing the heat transfer

Figs. 2a and 2b—Sample No. 2: 9.3 percent bentonite (by weight), 4.0 percent lime, 86.7 percent water—This sample also showed cracks almost immediately. Fig. 2a shows the result one week later, while Fig. 2b shows the result two weeks later. Again the sand has sifted downward, filling the large cracks which formed in the vicinity of the tube

worthwhile using special fills for heat pump ground coils rather than the local soil.

As a result of these tests and observations, the following conclusions have been drawn:

The use of bentonite with water does not seem worthwhile because of its tremendous swelling and shrinking characteristics with small changes in moisture content. Its use dry (either in powdered or solidified form) does not seem wise because of its insulation properties.

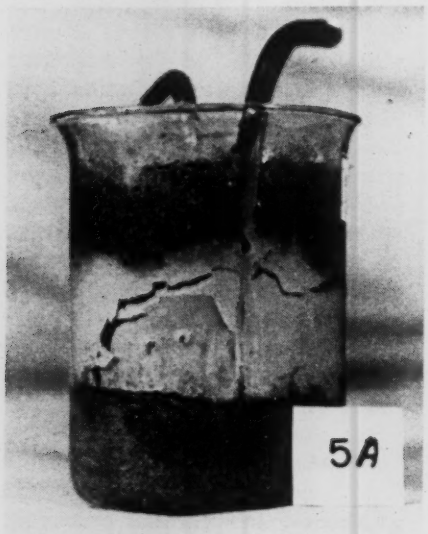
Calcium chloride—because of its corrosive effect on copper tubing—is undesirable, while lime seems to have little beneficial effect.

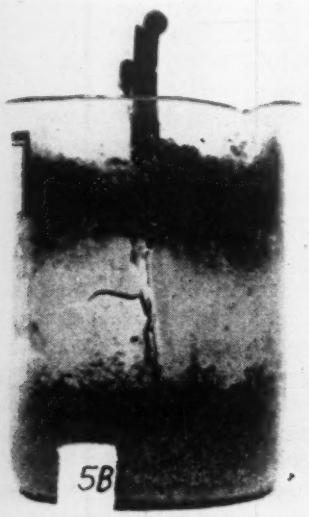
A small amount of silica gel with sand appears to be advantageous as cracks do not appear and moisture is retained, thus giving conditions conducive to good heat transfer.

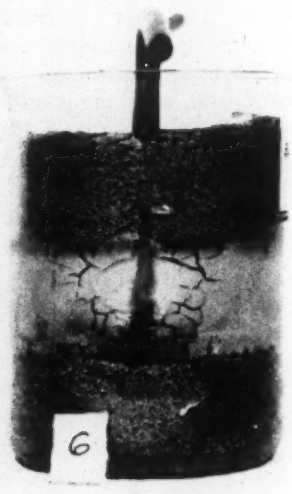
When bentonite is mixed with oil it seems to lose its tendency toward excessive expansion and contraction. It, too, is a promising method

Figs. 5a and 5b—Sample No. 5: 10.5 percent bentonite, 9.5 percent calcium chloride, 80.0 percent water—This sample acted in much the same manner as No. 4. Fig. 5a shows the shrinkage cracks within the mixture after one week test and Fig. 5b shows the cracks around the tube after two weeks test. These pictures are of opposite sides of the beaker to show different conditions. Corrosion was also evident

Fig. 6—Sample No. 6: 100 percent bentonite—The top and bottom sand layers were saturated with water while the bentonite was put in dry. The moisture gradually worked into the bentonite and caused the originally dry powder to shrink into a more dense mass as well as to crack in the immediate vicinity of the tube between layers. The cracking in the vicinity of the tube appeared to be a result of the greater drying of the mixture in this region. This picture shows the result after two weeks operation







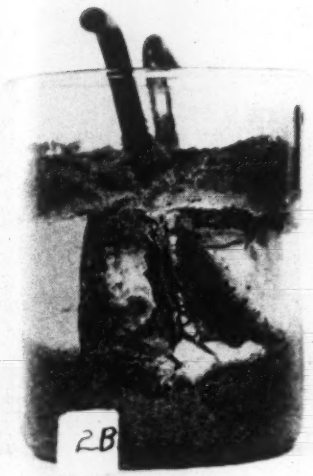


Fig. 3—Sample No. 3: 3.0 percent bentonite, 54.2 percent sand, 42.8 percent water—This sample was slower to show cracks. One week later a number of fine cracks around the pipe were very noticeable and two weeks later, as shown here, the cracks had enlarged somewhat and the whole mass had shrunk away from the bottom sand layer. It is felt that the very porous nature of the material immediately surrounding the tube would have poor heat transfer properties.

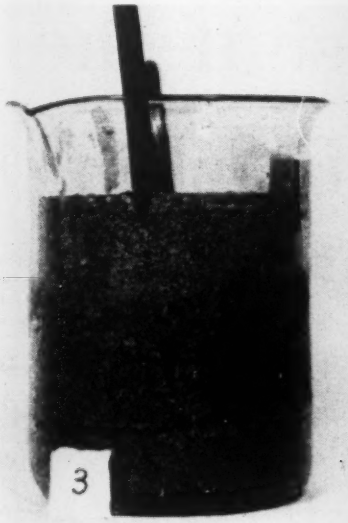
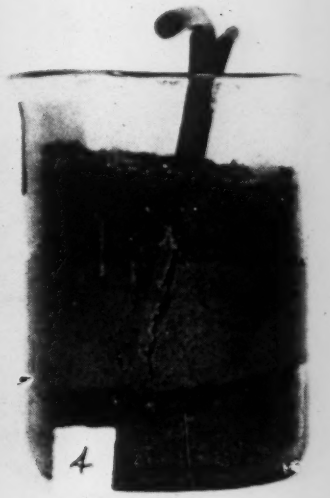


Fig. 4—Sample No. 4: 18.0 percent bentonite, 12.2 percent sand, 10.3 percent calcium chloride, 59.5 percent water—This showed a general tendency to shrink away from both upper and lower layers of sand as well as around the pipe. The picture shows the result two weeks after the start. This sample also showed a marked tendency to corrode the tube as a result of the calcium chloride in the mixture



of fill around tubes where heat must be dissipated.

It was also apparent from a close examination of the samples and pictures that the sand layers always maintained their contact with the tubes. Therefore, it is possible that plain sand fill may be the cheapest solution. The conductivity of this sand might be increased by adding a small amount of silica gel to increase the moisture content and fill the voids between sand particles. If special fills were to be considered, it might be advisable to use a mixture of bentonite and oil though this would make it impossible to use the heat of fusion as a source of heat. Sand mixed with bentonite and oil would reduce the amount of bentonite and oil needed.

Before any of these fills are used, however, they should be studied carefully as to their heat transfer properties—particularly where bentonite is used, because it is an insulator in powder or solid form.

Fig. 7—Sample No. 7: 100 percent silica gel—The sand was wetted in both layers and the silica gel absorbed moisture from this sand. The heat tended to dry the silica gel in the region around the tube and cracks formed slowly. No corrosion occurred.

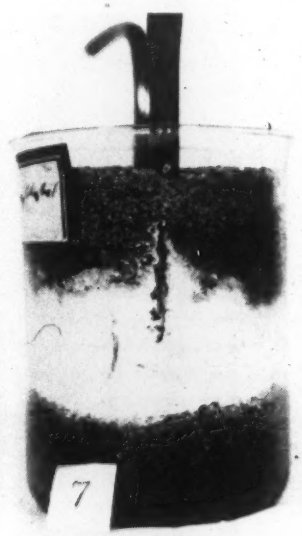


Fig. 8—Sample No. 8: 5 percent silica gel, 95 percent sand—The upper and lower layers of sand were wetted to provide moisture for silica gel to absorb. This picture shows very little change occurred in the sample over a period of two weeks

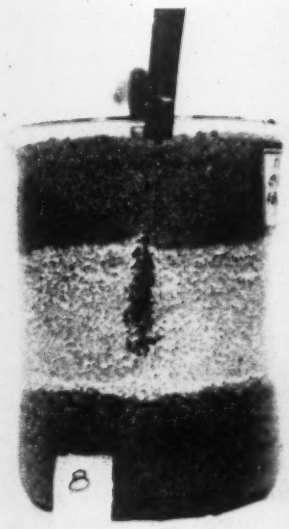
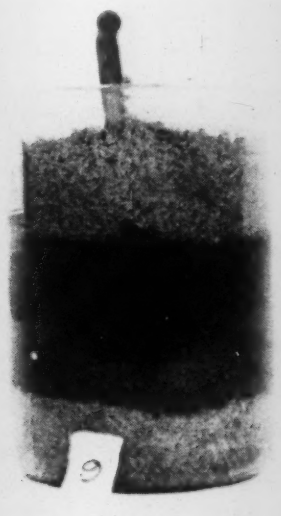


Fig. 9—Sample No. 9: 57.2 bentonite, 42.8 percent oil—The mixture showed very little change after one or two weeks operation. After four weeks it showed very small air bubbles around the tube. Picture shows the sample after four weeks operation



How to Design the Piping for Conveying Flashing Hot Water

***THEODORE E. BRIDGE**, a mechanical engineer with the University of Chicago in connection with a project under construction for the Argonne National Laboratory, acquired a wide experience in the design of power and of process piping during 15 years with E. I. du Pont de Nemours & Co.; he has also had experience in the field of very high pressures.*

In his article, of which this is the second part, his objective is to help the "average engineer" in applying theory to the problem of designing piping systems for conveying flashing mixtures of steam and water. His article is, we feel, a significant and most practical contribution to the subject of piping

THE AVERAGE engineer needs a lot of help in applying theory to the design of piping systems for conveying flashing mixtures of steam and water. This article has been written with the objective of giving the help required in solving everyday problems. The theory is reviewed in the appendix in order that the method may be understood. Curves are also presented from which precalculated data may be obtained. Without these curves it would be necessary to perform several graphical integrations, and to resort to cut and try methods to solve even the simplest of problems. Sample problems are given to demonstrate the calculation of pressure drop in four types of problems. In addition, a theory is developed for calculating surge pressures resulting from the high velocities which are usually encountered in condensate lines. Finally, suggestions are given for designing flash tanks.

Sample Problems

In the following sample problems, it is assumed that the pressure in the flash tank is lower than the critical pressure; therefore, the pressure in the outlet end of the piping will be the critical pressure. The fluid, on entering the flash tank, will literally explode, and the concussion from the explosion will maintain critical pressure at the outlet of the piping system.

CASE 1—PIPING SYSTEM WITH NO ORIFICE INSTALLED

Given: $L'' = 200$ ft; 1 in., schedule 40 pipe; $D = 1$; $Pi = 150$ psi.

Calculate: The maximum flow through the pipe (M).

$T = 200$ ft; $T/D = 200$; $A = \pi D^2/4 = 0.78$.

From Fig. 5, $M/A = 12.5$; therefore, $M = 0.78 \times 12.5 = 9.8$.

CASE 2—ORIFICE INSTALLED AT INLET END OF LONG LINE

Given: $L'' = 47$ ft = the actual equivalent length of the piping and fittings installed in the system. The piping is 1¼ in., schedule 40; therefore, $D = 1.38$. The inlet pressure $Pi = 100$ psi.

Calculate: The area of the orifice (Ao) and the maximum flow through the system (M).

In solving Case 2 problems, it is recommended that T be made arbitrarily equal to 5 L''.

$A = \pi D^2/4 = 1.495$.

$T = 5 \times L'' = 5 \times 47 = 235$, therefore $T/D = 171$.

From Fig. 5, $M/A = 10$; therefore, $M = 10 \times 1.495 = 14.95$.

$Lo = T - L'' = 188$, and $Xo = Lo/T = 0.80$.

Therefore, from Fig. 6, $Yo = 0.37 = (Pi - Po)/(Pi - P'')$.

From Fig. 7, $P'' = 42$ and $(Pi - P'') = 58$.

Substituting above, $(Pi - Po) = 0.37 \times 58 = 21.4$.

Next, Equation 10, which is given in Appendix B, is solved as follows:

$$Ao = 0.0529\, M/\sqrt{Pi - Po} = 0.0529 \times 14.95/\sqrt{21.4} = 0.170.$$

The above value of Ao must be divided by 0.60 (the coefficient of discharge) to obtain the actual area of the orifice to be used in the design.

Surge Pressure at an Elbow

Continuing the above example, the following will illustrate the calculation of surge pressure at an elbow installed at a point 15 ft downstream from the orifice. Therefore, $Le = Lo + 15 = 188 + 15 = 203$ ft.

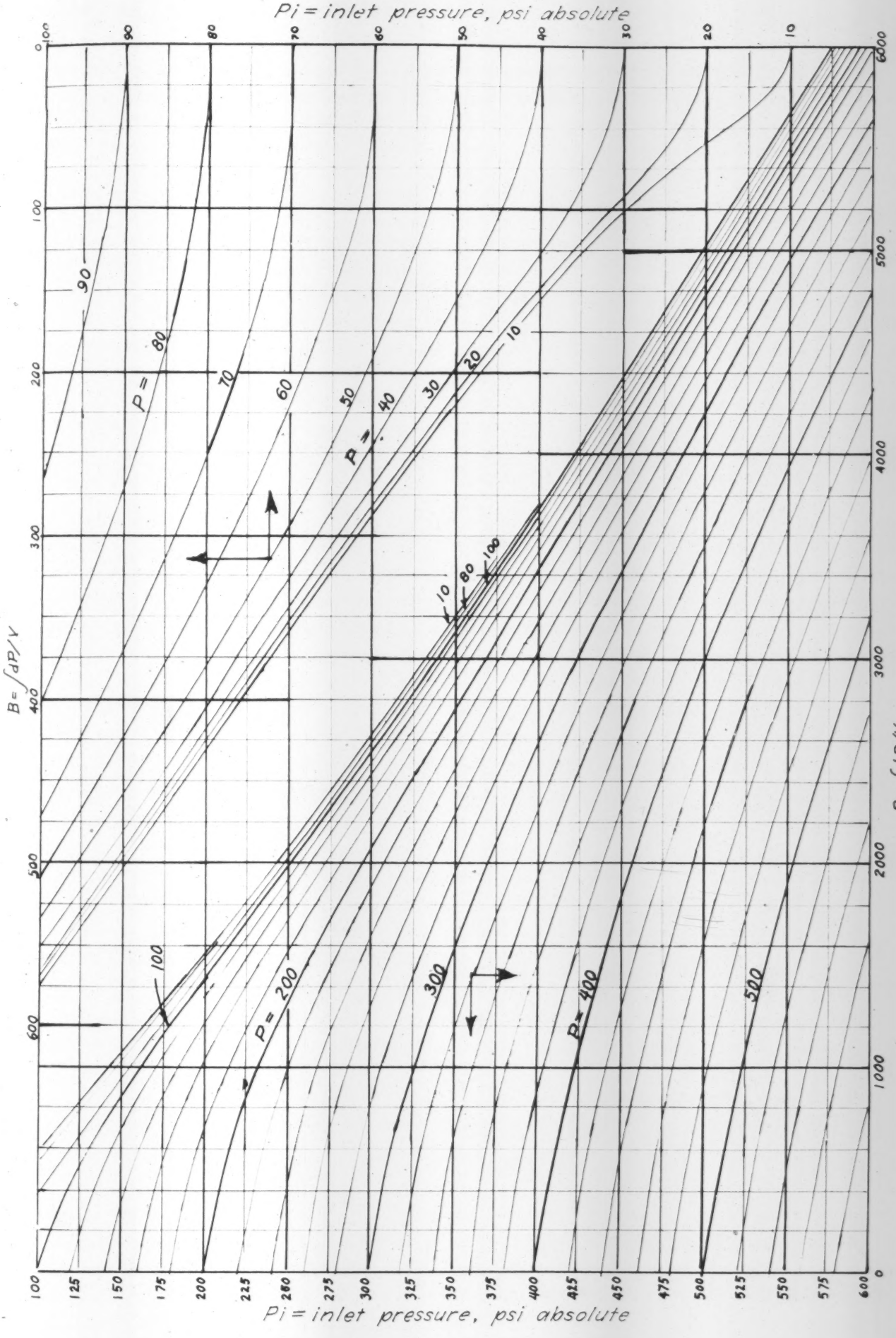
Let the radius of the elbow $R'' = 2.1$ in. Therefore, $N = R''/D = 1.52$.

The surge pressure (S) is calculated as follows:

$Xe = Le/T = 203/235 = 0.86$. From Fig. 6, $Ye = 0.46$.

$(Pi - Pe) = (Pi - P'')\, Ye = 58 \times 0.46 = 26.6$.

Fig. 1 (Opposite)—These curves are used to determine the value of the integral $B = \int dP/V$ when employing Equation 7 in Appendix A for calculating pressure drop in a pipe line. (dP is total differential pressure drop, psi; V is the specific volume of the steam-water mixture in the pipe, cu ft per lb; P is the pressure at any point in the system, psi absolute)



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SYMBOLS

A = actual cross sectional area of pipe, sq in.

Ao = theoretical cross sectional area of orifice, sq in.

Av = area of vent on flash tank, sq in.

Af = cross sectional area of flash tank, sq in.

B = constant read from curves in Fig. 1, $B = \int_{Vi}^{V} dP/V$

Bo = the same constant read from curves letting $P = Po$

B'' = the same constant read from curves letting $P = P''$

C = constant read from curves in Fig. 2, $C = 31.9 \log (V/Vi)$

Co = the same constant letting $P = Po$

C'' = the same constant letting $P = P''$

D = inside diameter of pipe, in.

D' = inside diameter of pipe, ft

Do = diameter of orifice, in.

dp' = differential pressure drop due to friction, psf

dp'' = differential pressure drop due to inertia, psf

dp = total differential pressure drop, psf

dP = total differential pressure drop, psi

dt = differential time for fluid to travel distance dL, sec

dL = differential length of pipe, ft

E = constant read from curves in Fig. 2, $E = V/Vi$

f = dimensionless friction factor ($f = 0.003$)

G = mass velocity, lb/sec ft^2, $G = U/V = 144\ M/3.6\ A$

g = acceleration given to a 1 lb mass by a 1 lb force = 32.2 ft/sec^2

H = lost head due to friction, ft

K = Williams and Hazen roughness coefficient

L = the equivalent length of the system measured from the inlet end up to the point where P is measured, ft

Lo = the equivalent length of the system measured from the inlet end up to the point where Po is measured, ft

L'' = the equivalent length of the system measured from the point where Po is measured and continuing on to the end of the system, ft

M = the mass flow through the system, thousands of lb per hr

N = the radius of the pipe bend expressed as number of pipe diameters

P = the pressure at any point in the system, psi absolute

Po = the pressure between the two parts of the system, namely the piping and the orifice. For example, if the orifice is at the inlet end of the system, Po would be the pressure at the outlet of the orifice, psi absolute

P'' = the critical pressure as read from the curves in Fig. 7, psi absolute

q = the volume flow of water assuming no flashing, gpm

R = the mean radius of the pipe bend or elbow, ft

R'' = the mean radius of the pipe bend or elbow, in.

S' = surge pressure, psf

S = surge pressure, psi

T = the total equivalent length of the entire system including pipe, fittings, and orifice ($T = Lo + L''$), ft

U = fluid velocity through the pipe ($U = dL/dt$), ft/sec

V = the specific volume of the steam water mixture in pipe, cu ft/lb

Vo = specific volume at point where Po is measured, cu ft/lb

$X = L/T$

$Xo = Lo/T$

$Y = (Pi - P)/(Pi - P'')$

$Yo = (Pi - Po)/(Pi - P'')$

Subscripts indicate conditions applying at specific points as follows:

e = At any elbow in the system

f = At the flash tank

i = Inlet of system

o = At the orifice.

$Pe = Pi - 26.6 = 73.4$.

From Fig. 2, $Ee = 10$.

From Equation 11, which is given in Appendix C, $Ue = 0.641\ Ee\ (M/A) = 0.641 \times 10 \times 10 = 64.1$ ft/sec.

From Equation 15, given in Appendix C, $S = U^2/[94.5\ (N + 0.33)] = 4100/[94.5 \times (1.52 + 0.33)] = 23.5$.

The surge pressure will add to the static pressure in the elbow to give a total pressure of $(Pe + S) = 73.4 + 23.5 = 96.9$ psi.

It must be understood that the surge, as calculated, is not a continuous pressure. It comes and goes as the slugs of water pass through the elbow.

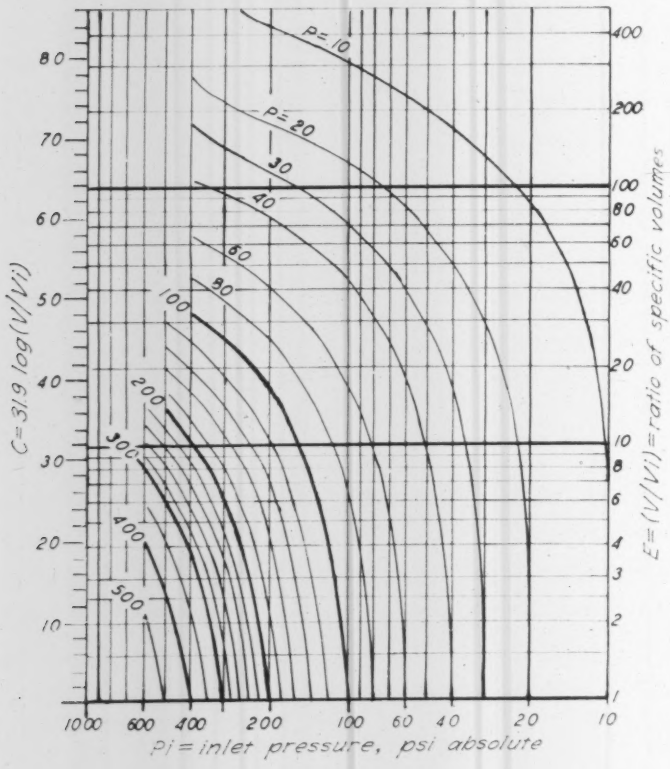
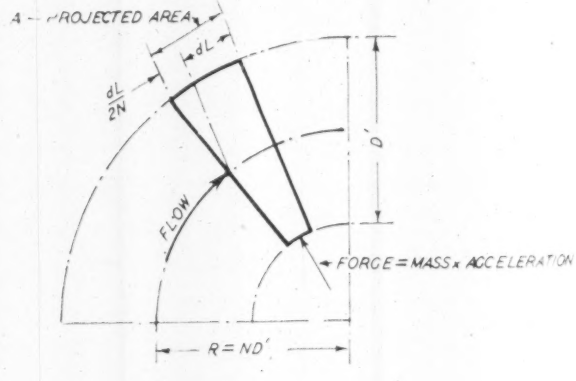


Fig. 2 (Left)—These curves are used to determine values for the constants C and E which are needed in Equation 7 when calculating pressure drop and Equation 11 when figuring velocity, respectively. (V is specific volume of the steam-water mixture in the pipe, cu ft per lb; Vi is the specific volume at the inlet of the system). Fig. 3 (Below)—Inertia force acting on a slug of water traveling around an elbow at high velocity (dL is differential length of pipe, ft; N is radius of pipe bend expressed as number of pipe diameters)



Although the surge as calculated for this problem was moderate, it can often reach very considerable proportions at points near the flash tank where critical velocity is approached. It may be desirable, in some cases, to install long radius elbows with large values of N (say from 5 to 10) at critical points where the surge pressure is figured to be large.

Design of the Flash Tank

The following will illustrate the design of a flash tank to handle the flow as calculated for this problem:

It may be assumed that the flash tank is operating at 15 psi gage, so that Pf = 30 psi absolute.

From Fig. 2, E = 70.

From Equation 17, in Appendix E, Av = 0.00641 E M = 0.00641 × 70 × 14.95 = 6.71.

From Equation 18, Af = 0.214 E M = 0.214 × 70 × 14.95 = 224 sq in. This would correspond to a 3 in. diameter vent pipe on an 18 in. diameter tank. It is recommended that the 1¼ in. inlet pipe be installed to discharge tangentially into the tank.

CASE 3—ORIFICE INSTALLED AT OUTLET END OF A PIPING SYSTEM

Given: The equivalent length of piping actually installed is 47 ft of 1¼ in. schedule 40 iron pipe. Lo = 47, D = 1.38, A = 1.495 and Pi = 100 psi absolute.

Calculate the area of the orifice Ao and the maximum flow through the system (M).

[*Note: There are several doubtful assumptions made in the development of the theory used in the solution of this problem. This theory should be used only when it is impractical to collect experimental data on which to base the design.*]

In solving "Case 3" problems, it is recommended that T be made arbitrarily equal to twice the actual equivalent length Lo. Therefore, T = 2 Lo = 2 × 47 = 94 ft and T/D = 68. From Fig. 5, M/A = 15, and M = 15 × 1.495 = 22.4, so M^2 = 502. Xo = Lo/T = 0.50, and (from Fig. 6) Yo = 0.12 = $(Pi - Po)/(Pi - P'')$. From Fig. 7, P'' = 52, and $(Pi - P'')$ = 48. Therefore, $(Pi - Po)$ = Yo $(Pi - P'')$ = 0.12 × 48 = 5.76, and Po = 100 − 5.76 = 94.2.

Pi = 100	Po = 94.2	P'' = 52	Difference
From Fig. 1.....	Bo = 130.....	B'' = 525.....	$(B'' - Bo)$ = 395
From Fig. 2.....	Co = 11.....	C'' = 44.....	$(C'' - Co)$ = 33

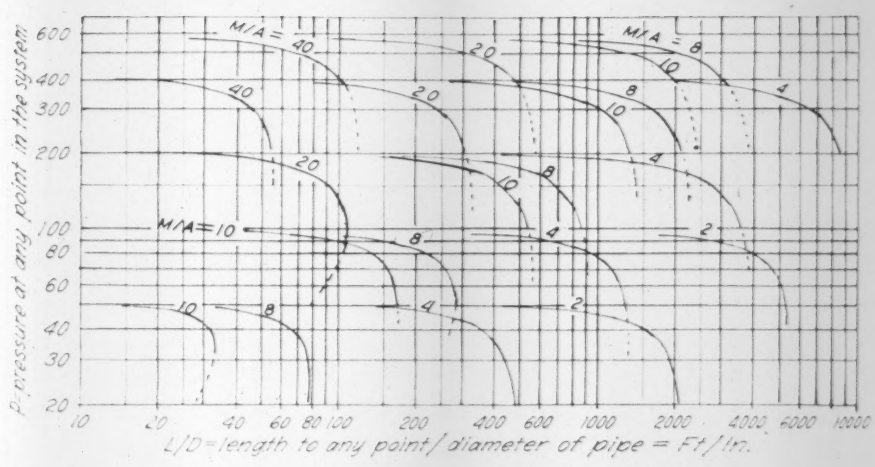


Fig. 4—Results of 21 separate calculations showing how the pressure in the pipe varies with the length (M is mass flow through the system in thousands of lb per hr, and A is cross sectional area, sq in.)

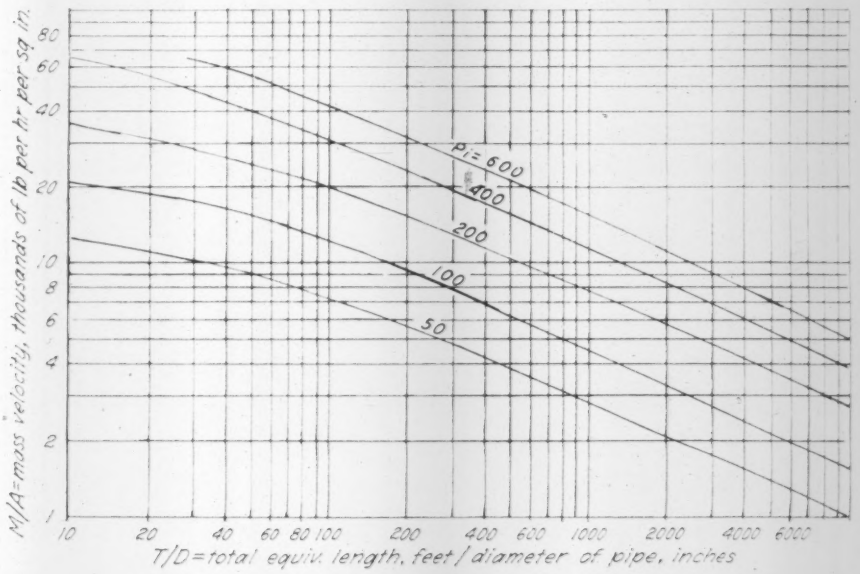


Fig. 5—How the mass velocity through the system varies with pressure and the equivalent length of the system (Pi is inlet pressure, lb per sq in. absolute)

From Equation 16, in Appendix D, Ao^2 = M^2 $(C'' - Co)/(B'' - Bo)$ 40.3 = 502 × 33/395 × 40.3 = 1.04. Therefore, Ao = $\sqrt{1.04}$ = 1.02.

It will be noted that most of the pressure drop in this problem is taken across the orifice. Even so, the orifice diameter calculates to be 83 percent of the diameter of the pipe. Obviously, it would be impractical to make the orifice any bigger, so the coefficient of discharge must be applied to the flow M. The actual capacity of the line and orifice would, then, figure out to be 0.6 × 22.4 = 13.4 thousand lb per hr.

It is believed that on account of the very high orifice ratio, it might be proper to assign a higher value for the coefficient of discharge, but it was decided to use 0.60 by way of applying a "factor of ignorance."

CASE 4—ORIFICE INSTALLED AT OUTLET END OF A PIPE LINE, BUT THE PIPE IS EVERYWHERE SUBMERGED BELOW THE HYDRAULIC GRADIENT SO THAT NO FLASHING CAN OCCUR

Given: Assume that a ¾ in. schedule 40 pipe in a continuous blowdown system drops directly out of a boiler drum through two elbows close to the drum and then to a third elbow 20 ft below the water level in the drum. Further, assume that the pipe runs level and straight for a distance of 100 ft where it connects to a control valve mounted

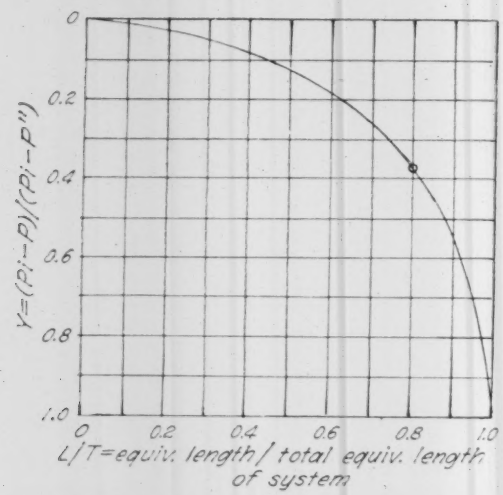


Fig. 6—This curve represents approximately any one of the curves shown in Fig. 4. It is accurate at only one point as indicated by the small circle on the curve. (*Pi* is pressure at inlet of system, psi absolute; *P* is pressure at any point in the system, psi absolute; and *P"* is the critical pressure as read from Fig. 7, psi absolute)

on a flash tank. The pressure will be taken as 100 psi absolute in the drum and 30 psi absolute in the flash tank. A summary of the data given follows:

$Pi = 100$ and $Pf = 30$.

Vertical run, 20 ft.

Horizontal run, 100 ft.

Three elbows (estimate 2.6 ft each), 8 ft.

Total equivalent length, *Lo*, 128 ft.

In addition to the above, assume that the system is to pass 2000 lb per hr. Therefore, $M = 2$ and $q = 4$ gpm.

It will be shown later that no flashing can occur in this problem. Accordingly, it does not really fall within the scope of this article, but the problem is included to explain how one determines if the line is submerged below the hydraulic gradient.

In an actual problem, it might be well to draw the hydraulic gradient on the drawing in elevation view; the designer would then make every effort to keep all piping below this line. Since no flashing can occur, any formula applying to cold water will approximately apply for this problem also. The following formula by Williams and Hazen [see Cameron Hydraulic Data, edited by G. V. Shaw and A. W. Loomis, Ingersoll-Rand Co., 11th edition, page 28] is one of many that have been used to calculate the pressure loss in the piping.

$$H = 0.002083\ (100/K)^{1.85} \times q^{1.85} L/D^{4.865}$$

$K = 100$, $D = 0.824$, $D^{4.865} = 0.388$,

$q = 4$, $q^{1.85} = 13$.

$$H = (0.002083 \times 1 \times 13 \times 128/0.388) = 8.9$$

Because the horizontal run of pipe is everywhere submerged more than 8.9 ft below the water level in the drum, no flashing can occur. $(Pi - Po) = (H/2.31) = 3.85$, and $Po = 100 - 3.85 = 96.2$. In this problem the symbols have slightly different meaning than those used in Appendix B, where the formula that we will use is developed. As far as the orifice is concerned, *Po* is the pressure ahead of the orifice, and *Pf* is the pressure at the outlet of the orifice.

Therefore, Equation 10 may be rewritten as follows:

$$Ao = 0.0529\ M/\sqrt{Po - Pf}$$

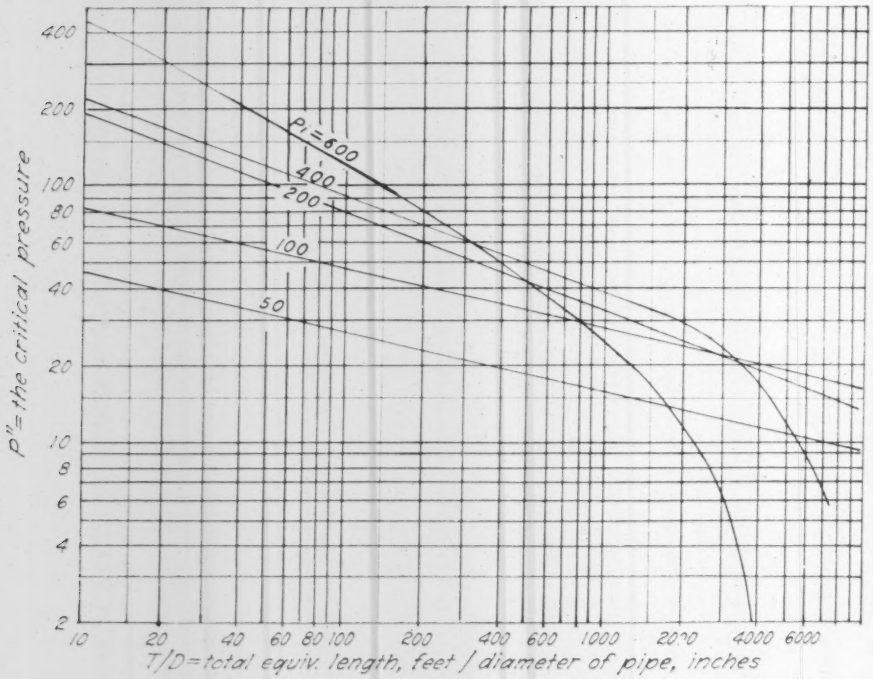
The known values can readily be substituted in the above equation:

$$Ao = 0.0529 \times 2/\sqrt{96.2 - 30} = 0.013$$

The above value for *Ao* should be divided by an appropriate value for the coefficient of discharge (say 0.60) to obtain the actual area required by the orifice.

[To be continued]

Fig. 7—These curves are used to determine the critical pressure in the system, *Pi* being the pressure at the inlet of the system, psi absolute



CORROSION SHORT COURSE BEING CONSIDERED

Engineers and management specialists interested in attending a short course in corrosion engineering are invited to write Nathan Schofer, Cities Service Refining Corp., Tutwiler Refinery, Lake Charles, La. Mr. Schofer is chairman of a committee named by the south central region of the National Association of Corrosion Engineers to get a consensus of the proposed course, and if sufficient interest is evidenced, make arrangements with a university engineering school to hold it this year.

Letters expressing interest should define the specific aspect of corrosion in which the writer is interested, forecast the number likely to attend, the most suitable time it should be held, and give any other pertinent comments.

REPLACEMENT SELLING MAY TOTAL 50 PERCENT

"Replacement selling may eventually reach 50 percent of the total sales volume of air conditioning and commercial refrigeration equipment—perhaps as early as 1949," according to W. F. Switzer, commercial sales manager of the Frigidaire Div. of General Motors.

Mr. Switzer said that he based his opinion on trends which have developed since wartime.

THE "DONORA INCIDENT"

ALLEN D. BRANDT, industrial hygiene engineer, Bethlehem Steel Co. Bethlehem, Pa., comments on the "meteorological accident" at Donora, Pa., last fall, points out its particular significance to industrial ventilation engineers.

BEGINNING October 27, 1948, meteorological conditions in the vicinity of Donora, Pa., became such as to prevent or inhibit the natural rise and escape of atmospheric contaminants discharged by the homes, factories, mills, and railway equipment in this part of the Monongahela river valley. This atmospheric inversion continued until sometime during October 30, causing a degree and type of atmospheric pollution referred to by early press reports as a "mysterious airborne plague." About 20 people died, and it is estimated that over 400 people in this area became sufficiently ill to require medical attention.

Those engaged in air pollution control and industrial hygiene—and many other ventilating engineers—will remember a similar incident that occurred in the Meuse valley, Belgium, in 1930. In this disaster, more than three-score people died and, according to press reports, thousands became ill. The meteorological, chemical, and medical aspects of these two "incidents" apparently were similar.

Studies following the Meuse disaster indicated that in the absence of wind a fog settled over the valley for several days, and because of the meteorological conditions an atmospheric ceiling was established about 300 ft from the ground. This ceiling prevented the atmospheric contaminants discharged by industries and homes from escaping, with the result that the concentrations mounted to a level of hygienic significance. What gas or gases were responsible for the fatalities and illnesses is not known definitely. It is believed that sulfur dioxide and sulfur trioxide were responsible, although fluorides have been mentioned also. As in the occurrence at Donora, the first victims were sufferers from pulmonary and cardiac disease, and most fatalities were elderly inhabitants.

The Donora affair might be termed a repeat performance, for all aspects were similar. Donora is a town of about 12,000 population 25 miles southeast of Pittsburgh, in a heavily industrialized valley. Soft coal is a popular domestic fuel. A dense fog with a low atmospheric ceiling settled over this area October 27 and remained until October 30. Such atmospheric conditions occur only infrequently, and it is extremely rare that they last for several days. The conditions have been referred to as a "meteorological accident." Sulfur dioxide and sulfur trioxide have been given most commonly as the probable cause of the fatalities and illnesses, but here too, fluorides have been mentioned.

Unfortunately, atmospheric sampling was not being done in the vicinity of Donora throughout the period of this incident. Sampling was begun about 8:00 a.m. October 30 by the Pennsylvania Bureau of Industrial Hygiene, but at least one industry in the area had ceased operations at 6:00 a.m. of the same day because of the prevailing conditions; possibly the atmospheric ceiling began to lift about this time, so that the findings of the bureau probably do not represent the peak concentrations. The sulfur dioxide concentrations measured decreased from a high of 0.54 parts per million at 8:23 a.m. to 0.08 at 1:20 p.m. A large number of subsequent samples taken between October 30 and November 10 ranged between 0 and 0.75 parts per million of sulfur dioxide. Apparently sulfur also was found to be present in significant amounts, but no fluorides were found by the bureau in its atmospheric studies in the Donora area. A joint study of major proportions has been undertaken by the Pennsylvania Health Department and the U. S. Public Health Service. It is hoped that this investigation will ultimately supply answers to the many questions in our minds at present.

The maximum allowable concentration or hygienic standard for sulfur dioxide in common use by toxicologists and industrial hygienists today is 10 parts per million. Lower concentrations are irritating to some normal persons, and it is possible that much lower concentrations may be harmful to elderly people suffering from certain pulmonary or cardiac diseases. The majority of the people affected adversely by the Donora smog were elderly persons. Whether sulfur dioxide or sulfur trioxide is to blame cannot be stated at present. Postmortem examinations of those who died might have provided a worthwhile lead as to the causative agent, but apparently few if any such examinations were made.

Natural escape of atmospheric contaminants was prevented

Significance to Ventilating Engineers

Probably the greatest significance of the Donora incident to HPAC's readers is the influence it will have on air pollution control or smoke abatement. Mounting public activity pertaining to smoke control ordinances is being reported from more and more cities and states. Those ventilating engineers who handle considerable industrial ventilation should take note, because increased emphasis is imperative on more complete removal of the dust and gas from air discharged to the outside atmosphere by industrial exhaust systems.

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DATA SHEET

Chart for Determining Air Volume, Relative Humidity & Temperature

By Byron A. Engelbach, Plant Engineer
New England Confectionery Co.
Cambridge, Mass.

THIS CHART for determining air volume, relative humidity, and temperature can be used in calculations where moisture regain is involved, and specifically in problems connected with heating, evaporative cooling, dehumidification, and humidification.

Much research is presently focussed on the flow of water vapor through materials under varying pressures, towards establishing a factor which will be analogous to the *k* factor used in heat conduction calculations. From such research, engineers will receive valuable information which will undoubtedly standardize methods of calculations. Until such information is more widely available, less academic means have been and are being devised to simplify the engineer's work.

The accompanying chart was primarily designed by the author for just such a purpose. Practical observations in practice accredited by subsequent operational tests have made it possible to set up a rule which has come within 20 percent of meeting specifications under nearly all standard conditions. That is to say, it allows for adequate replacement within 80 to 100 percent operation of the equipment.

The formula is shown on the chart. The vapor pressure is taken at design conditions. It is assumed that a 1 mm of mercury vapor pressure will exist at outside conditions when peak load conditions occur in conditioned areas (minimum winter conditions). The use of 6 as a divisor is based on practical applications with area enclosures of standard construction without special vapor seal treatment. It has been found in practice that in concrete buildings with glass block window treatment, the multiplying factor varies due to the divisor being something less than 6.

The chart was originally designed to simplify calculations in connection with applications of humidifying equipment which eliminates free moisture discharged into the controlled zone. Applications of this nature have been made since 1939 under the Cummings patents. Having the means of adding vapor without the use of atomization or carrying air, it was essential to know within a reasonable accuracy the quantity required and the vapor pressure head necessary for self-distribution and various penetration requirements.

An example of such an application was in the printing industry, where repeated impressions were necessary in color printing. Running periods covered several days and a constant moisture content in the paper had to be maintained to give accurate register. Another application was in connection with the combing process in a textile plant.

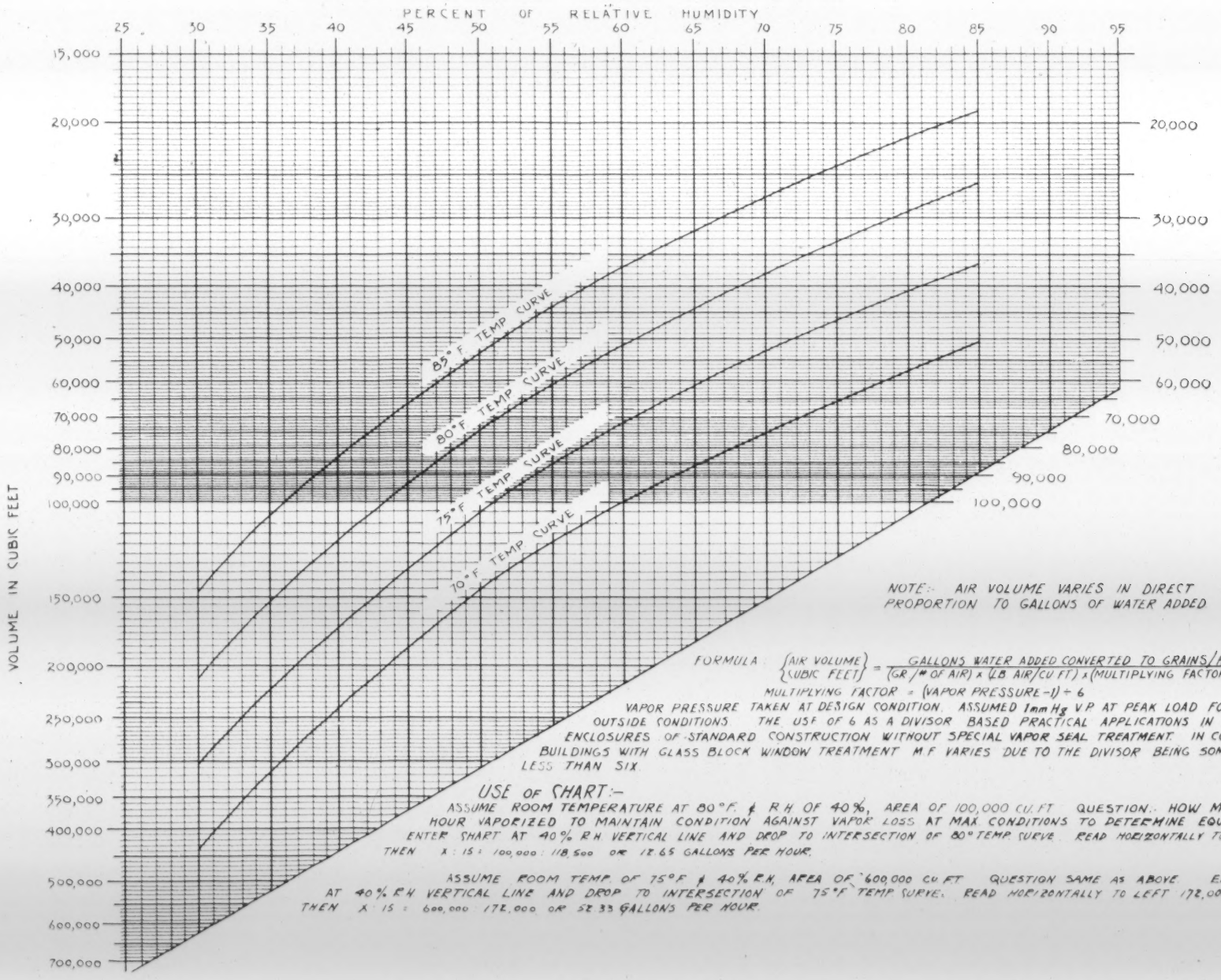
Since the chart was designed, further uses have been found which can be advantageously applied in general problems.

A typical use for the chart is in the calculation of heating loads where a winter air conditioning system is used and provides humidification. This problem occurs in residential as well as industrial problems. In such a problem, the total heat required (which will include the humidification load) may easily be calculated from information available on the chart, since the weight of water to be added can be arrived at on the chart and heat of vaporization of this water is then easily found. Size of boiler and radiation requirements may be appreciably affected by such a load, especially in residential calculations.

It very often becomes necessary to know within reasonable limits the total vapor loss from a conditioned industrial area. Such knowledge is necessary in the determination of humidifying equipment needed to maintain predetermined conditions. The water input as found from the chart will not give total water required on systems where free moisture is present in the conditioned area. However, the water input calculated from the chart can be used directly in determination of humidifying equipment where no free moisture is present and no air, or very little air, is used, or for determining the evaporative cooling effect in either case.

CHART FOR DETERMINING AIR VOLUME-RELATIVE HUMIDITY-TEMPERATURE

BASED ON 15 GALLONS PER HOUR WATER ADDED



NOTE:- AIR VOLUME VARIES IN DIRECT PROPORTION TO GALLONS OF WATER ADDED

FORMULA: $\frac{\text{AIR VOLUME}}{\text{CUBIC FEET}} = \frac{\text{GALLONS WATER ADDED CONVERTED TO GRAINS/HR}}{(\text{GR}/\#\text{ OF AIR}) \times (\text{LB AIR/CU FT}) \times (\text{MULTIPLYING FACTOR})}$

MULTIPLYING FACTOR = (VAPOR PRESSURE - 1) ÷ 6

VAPOR PRESSURE TAKEN AT DESIGN CONDITION. ASSUMED 1mm Hg V.P AT PEAK LOAD FOR OUTSIDE CONDITIONS. THE USE OF 6 AS A DIVISOR BASED PRACTICAL APPLICATIONS IN AREA ENCLOSURES OF STANDARD CONSTRUCTION WITHOUT SPECIAL VAPOR SEAL TREATMENT. IN CONCRETE BUILDINGS WITH GLASS BLOCK WINDOW TREATMENT M.F. VARIES DUE TO THE DIVISOR BEING SOMETHING LESS THAN SIX.

USE OF CHART:-

ASSUME ROOM TEMPERATURE AT 80°F. & R.H. OF 40%, AREA OF 100,000 CU. FT. QUESTION:- HOW MUCH WATER PER HOUR VAPORIZED TO MAINTAIN CONDITION AGAINST VAPOR LOSS AT MAX. CONDITIONS TO DETERMINE EQUIPMENT SIZE? ENTER CHART AT 40% R.H VERTICAL LINE AND DROP TO INTERSECTION OF 80° TEMP. CURVE. READ HORIZONTALLY TO LEFT 118,500 CU. FT.

THEN X : 15 = 100,000 : 118,500 OR 12.65 GALLONS PER HOUR.

ASSUME ROOM TEMP. OF 75°F & 40% R.H. AREA OF 600,000 CU. FT. QUESTION SAME AS ABOVE. ENTER CHART AT 40% R.H VERTICAL LINE AND DROP TO INTERSECTION OF 75°F. TEMP. CURVE. READ HORIZONTALLY TO LEFT 172,000 CU. FT.

THEN X : 15 = 600,000 : 172,000 OR 52.33 GALLONS PER HOUR.

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QUESTION OF THE MONTH

YOU ARE invited to submit a heating, piping, or air conditioning question for publication here. You are also invited to submit answers to previously-published questions from others. Write the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

What's Been Experience With Control of Odors?

***THIS QUESTION** was asked by "S.E.C." in a request for information published in our February issue. He said that any comment reflecting actual experience would be particularly helpful, as his organization is investigating the matter of odor control in connection with their store buildings. A discussion in reply to "S.E.C." is published this month*

IN REPLY to the request of "S.E.C." published in the February issue of Heating, Piping & Air Conditioning for information on the control of odors in air conditioned buildings, methods of controlling or removing odors (gaseous and vaporous impurities) have been many and varied. Some introduce chemical agents into the air to destroy or decompose the contaminating elements while others act simply as a mask, hiding or screening disagreeable odors with presumably more pleasant ones. Removal of odors by condensation through reduction in air temperature and air washing or scrubbing are useful in certain laboratory or industrial processes but are impractical in general air conditioning work.

An efficient and economical means of controlling odors in air conditioned areas is to remove them by the process of *adsorption*, a natural physio-chemical phenomenon that occurs when condensable gases and vapors strike the surfaces of certain substances, one of these being activated carbon.

The concept and entire development of activated carbon air "recovery" or air purification relies on the premise that, in air conditioning, new outside air make-up, apart from that which may be required to offset infiltration, is necessary only for ventilation.

A persistent belief is that a considerable volume of new outdoor air must be supplied to maintain oxygen levels and to dilute carbon dioxide accumulation. Actually, in any above ground structure, air that infiltrates through doors, windows, and even walls will contain enough oxygen even under the worst occupancy conditions.

As new, unconditioned air is drawn in it replaces an equivalent volume of indoor conditioned air, the latter carrying with it the heating and cooling energy that has been expended upon it. Hence, the air conditioning system which reduces its outdoor air intake to a minimum approaches the efficient and economical.

The ratio of ventilation air to total air in any system will vary according to odor generation. The size of the conditioned area, the number of occupants, and their activity determine the odor level and hence the volume of ventilation air. A large, sparsely tenanted, office will need but little ventilation; usually, that required to offset infiltration will suffice. Conversely, a small crowded restaurant or store with a high odor generation from food and drink, tobacco smoke, perfumes, and cosmetics will need a large proportion of ventilation air if atmospheric "quality" is to be maintained. It is in just such situations that

activated carbon air recovery can be applied to best advantage.

Air recovery is simply the conversion of stale odorous air to fresh air. As the contaminated air comes in contact with the activated carbon, extraneous gases and vapors present condense and cling to the surfaces of the carbon. The action may be likened somewhat to that of a sponge soaking up water, although it differs in that the carbon *selectively* extracts airborne impurities. In passage through the carbon, neither the physical nor chemical properties of the air are altered.

The advantage of this method may be illustrated in two ways. Applied to purify the required portion of the recirculated air, the outdoor make-up air is reduced by an equivalent volume. Hence, the conditioning capacity and the cost of operation may be likewise reduced below what would otherwise be required. Another viewpoint would be to regard purified air simply as ventilation air. The function is identical. Instead of reaching outdoors for fresh air, the same effect is obtained directly from indoor air—air that is already at the proper temperature, humidity, etc.

Typical Restaurant Installation

A typical installation is that in the new Fifth Ave. Brass Rail restaurant in New York. Realizing the asset of an odorfree atmosphere, the owners installed a conditioning plant with sufficient capacity to furnish each patron with 20 cfm of fresh ventilation air, a total of 17,000 cfm. However, 10,000 cfm of this requirement is recovered from the recirculated air. Estimating 2½ tons of installed refrigeration capacity per 1000 cfm, there was thus a saving of 25 tons and the net cost reduction in refrigeration equipment is estimated at more than $5000. It would have been possible to cut down the outside air "load" even further were it not felt that 7000 cfm was necessary to dilute tobacco smoke. Activated carbon will effectively adsorb the irritating gases in tobacco smoke but the visible haze is, of course, a solid.

Air recovery equipment is essentially simple. The basic unit is the canister, consisting of an inner and outer perforated shell, between which is held the activated carbon filter medium. It is closed at the top but has a circular central opening at the bottom which fits into a hole in the supporting manifold plate. Spacing of the canisters is even to insure uniform air flow through the exposed area of each.

When applied to purify recirculated air, the units are located in the return air duct of the system. In general practice, the capacity of each canister will range from 20 to 35 cfm. Resistance between these limits varies from 0.15 to 0.25 in. water gage. They must be preceded by dry type dust filters to prevent clogging of the carbon.

The size of the installation depends, of course, on the volume of recirculated air to be purified. Suppose, for example, that it is desired

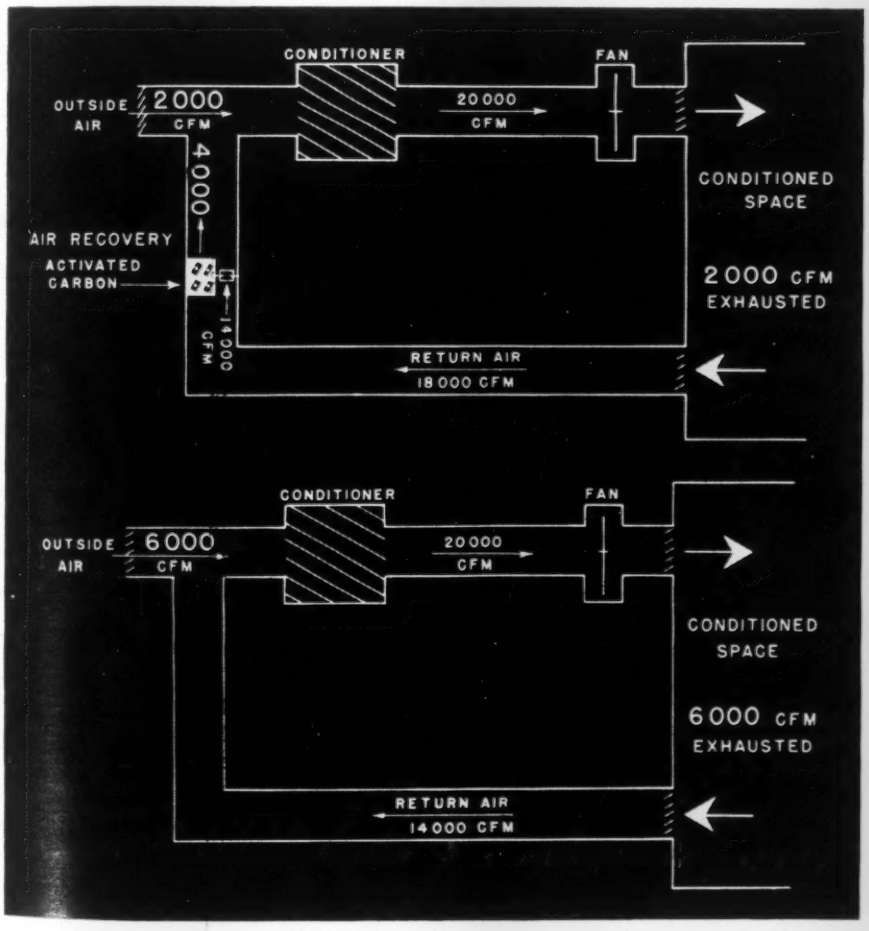
SEEKS AID ON PROPER STEAM HEADER DESIGN

You are invited to answer the following question from a reader of HPAC. Suitable comment on the matter will be welcomed, and—space permitting—will be published. Sketches and photos are particularly desired. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

Here's the question:

"I would appreciate having information and comment on the mixing of 125 lb, 85 lb, and 15 lb steam lines in a common return header to the boiler, and what method can be used to keep the back pressure down. Any suggestions for the proper design would be most helpful."—R.L.

Top: A typical air recovery installation. By purifying a portion of the return air, activated carbon equipment reduces the outside air load by two-thirds. Bottom: Without air recovery, the system must draw in three times as much outside air in order to maintain air "quality"



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Front view of air recovery unit at Fifth Ave. Brass Rail restaurant in New York. The dust filters have been removed to show one of the four tiers of activated carbon canisters

to decontaminate 4000 cfm. Assuming a capacity of 25 cfm for each, 160 canisters would be required. Arranged in four tiers, four canisters wide and 10 deep, a space approximately 1½ ft wide, 4 ft deep, and 9 ft high would be necessary. Various arrangements are possible.

When space is at a premium, as in public carriers and unit conditioners, and a canister installation is impractical, panel type units are employed. These consist of one or more rows of carbon-filled perforated metal tubes mounted in frames whose overall dimensions are similar to standard dust filters.

Depending upon the type and concentration of the odors in the air, the carbon will eventually adsorb its limit of condensed gases and reactivation becomes necessary, a process which drives off the condensate and restores the carbon to its original potency. In the usual comfort air conditioning installation, reactivation is necessary about once a year.

Railway Cars Use Air Recovery

A notable application of air recovery is in new railroad passenger cars. Railway cars must carry their conditioning plants "on their backs" and space and weight restrictions limit capacity to the extent that only 25 percent of the total air can be new air. In an enclosure of the size and with the high occupancy of a railway car, such a ventilation air volume is frequently insufficient. Car designers, however, by applying air recovery to treat half of the recirculated air, have raised the ventilation effect to 62½ percent. These units are standard equipment on many new passenger cars either now in service or being built.

Naturally, air recovery must be incorporated in the original installation if appreciable economies are to be obtained in capacity and operating costs. However, an existing system will often be found to lack the capacity to handle the outdoor air necessary for good ventilation. Air recovery can make good the deficiency in such cases. In other instances operating costs may be cut by reducing outdoor air make-up.

Where ductless "store" conditioners are used, all the air (except that supplied by normal infiltration) is constantly being recirculated; frequently, air quality can suffer under such conditions. Odor filters can be applied directly to the unit to supply ventilation by purifying the desired portion of the return air.

As people become increasingly conscious of air quality in air conditioning, this development would appear to find a growing usefulness.—J.E.O.

ASTM COMMITTEE REPORTS ON PIPING SPECS

The keynote at the meeting of committee A-1 on steel of the American Society for Testing Materials during its three-day session in Pittsburgh earlier this year was the review of existing specifications to bring them up to date. This involved consideration of requirements of other organizations, as well as rearrangement of requirements in existing documents to bring them more in line with present commercial practice. Work on several new specifications and methods is also well under way.

A specification consolidating the essential grades found in the present specification A 157 for alloy steel castings for valves, flanges and fittings for high temperature service and A 217 for alloy steel castings suitable for fusion welding for high temperature service is well under way. When this is adopted it is expected to supersede specifications A 157 and A 217. Various revisions are contemplated for specification A 182 covering steel for high temperature piping accessories, including revised chemical and physical requirements for grade F22 and a clearer definition of the various heat treatments given the austenitic steels. Specification A 181 for forged or rolled steel pipe flanges for general service is being expanded to cover also forged fittings and valves and parts. Progress is being made on the development of a specification for forgings for low temperature service. Agreement has been reached on a proposed specification for carbon, ferritic and austenitic steel pipe and tubing for low temperature service, and action on adoption is being started.

A special group has been established to correlate the grade numbers for the several types of steel common to the various commodities under the jurisdiction of the subcommittees on steel tubing and pipe and material for high temperature use.

SAM LEWIS' PAGE

Informal comment on heating, piping, and air conditioning matters is given in this regular feature by Samuel R. Lewis, consulting mechanical engineer, member HPAC's board of consulting and contributing editors

Heating Engineers Mustn't Overlook the Safety Angle

Many hazards to life and property exist in buildings, and are perhaps more often the result of changes and alterations made from time to time for one reason or another rather than being due to poor planning of the original design. Whatever the reason, however, any such hazards should be eliminated before they eliminate themselves (along with the building and the occupants)

HERE ARE some impressions developed during a little breathing space between engagements:

In England, in order to conserve the short coal supply, the ministry of fuel and power will send a regional fuel engineer to make suggestions to the owner for improvement of any plant, without cost to the owner. This service may cover ideas such as would occur to any competent heating engineer inspecting a new system, but is pointed particularly to improvements in combustion efficiency both as to physical construction and in operation.

The British gas council also maintains eleven industrial gas development centers located strategically and ready to give technical assistance to users of gas. Similar organizations using unpaid engineers were developed in this country during the war to give voluntary fuel conservation service upon request, but this ended with the war.

* * * *

In England, it appears that the boilers of many low pressure hot water heating systems have no relief valves or safety valves. Some disastrous boiler explosions have occurred following freezing of open relief outlets. One receives the impression that insurance of boilers is not nearly as universal in England as in the U. S., but the following remarks by the British board of trade commissioners are worth remembering as provocative toward the exercise of care by all of us:

"The owners of the heating plant are held financially responsible following an explosion that resulted in loss of life.

"No safety valve, and no other sufficient means were provided for relieving the boiler of excessive pressure.

"The management of the heating apparatus was not entrusted to a person of sufficient experience, and he was not properly or sufficiently instructed as to its safe management. No printed or written rules were supplied to him, and no supervision by a skilled and competent person was furnished. The boiler was not inspected periodically, as it should have been, by a qualified person."

* * * *

A recent ruling concerning hotels in New York is said to condemn revolving doors at any exits. There must be two separate exits to the street, remote from each other (except that if one of these is physically impracticable and is so certified by the authorities, an approved automatic sprinkler system may be installed and but one street exit then may be allowed).

Wire glass is not acceptable in a barrier around a stair shaft or in a panel of a door in a stair shaft.

Several large New York hotels have been torn down because of inability by the owner to comply with modern safety measures.

There are many tall old buildings

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in Chicago, particularly those having open stairways and elevator shafts, with large areas that could become gas chambers if fires ever start in the lower zones.

There are hundreds of old pipe shafts, open through many stories, carrying canvas covered insulation that burns easily and that could develop into sizable gas producers if fire ever started. All such shafts should be provided with an airtight, fireproof stop at every floor.

* * * *

I know of one office building in Chicago, more than 20 stories high, in which there are no easily visible interior stairways. The elevators and the outdoor fire escapes are the only way out for people on the upper stories. Interior stairways exist, but the entrances to them have been partitioned off by a rent-hungry administration until they are accessible only through the locked doors of the various tenants. I would be happy to attend a party with ropes and lamp posts for entertainment of the various people responsible for these violations of law and of commonsense safety.

* * * *

I know of a fire that occurred recently in an old skyscraper. The former operating engineer concluded that there was too much draft on the old manually fired water tube boilers. It seemed easiest to him to install—above the roof in the chimney, at about the 19th story level—a center hinged butterfly type steel damper. He fastened the damper in a partly open position, with wire. He was then called upon, rather suddenly, by a higher power to play the harp, and his successor never discovered the damper. After passage of some years the wire corroded, the damper closed, and the gases from the boilers discharged through various unauthorized holes that had been cut into the chimney by various tenants who desired local exhaust ventilation.

Of course, a belated interior inspection then was made throughout the chimney and all leaks were bricked up and all obstructions were removed. Adequate automatic draft control was then installed in the bottom of the chimney where it should originally have been placed. The owner, the fire insurance companies, and the fire department still are unhappy over this affair.

Modern Thinking Applied to Duct Design

IN THE article entitled Modern Thinking Applied to Duct Design, by Kirby Walker, in the March issue, there were some rather obvious errors that were made in copying the author's manuscript, which errors are regretted. On page 86, about halfway down the first column, the phrase "The ratio must consist of two numbers . . . " should read "The ratio *may* consist of two numbers . . . ". The thought intended was that not all ratios are nondimensional. In this particular subject the hydraulic radius is not nondimensional, even though it appears to be a ratio of area to perimeter.

On page 87, beneath Fig. 2, the symbol formulas should have parentheses. This would make $v = 242$ (poises), the object being to indicate that 242 times the poises, gives v, the absolute viscosity in pounds per hour per foot. In the same place, the cfm definition should read "*Actual* cubic feet per minute." Equivalent cfm at 70 deg is not used in these articles by Mr. Walker.

On page 88, in the second and third columns, reference is made to sheet metal ducts falling on the lower line of Fig. 2. This should read on the "lower two lines." This also applies to the first column, second paragraph, page 89. The theme of these paragraphs was to show how the lower two lines were for ordinary well built ducting, the bottom one of them being for round and rectangular shapes and the upper one for flat ducts. In the third column of page 88, "dotted cross line" should read "upper heavy solid line". In the first column, last paragraph, page 89, the first sentence should read ". . . are the maximum roughness we might get in duct work that might suggest we ought to pick a point *away* from the lower two lines". This was to demonstrate that in practical duct design the two lower solid lines in Fig. 2 apply with reasonable accuracy.

EASY ACCESS TO CANCER LAB PIPING

DISPOSAL OF acid wastes and specialized requirements for cancer research highlight the mechanical design of the recently completed Sloan-Kettering Institute in New York. The building is a modern, 15 story structure consisting primarily of laboratories designed specifically for the study of cancer.

Mechanical systems in the building were designed to provide laboratory technicians with every facility required to simplify and promote their research work. In furthering the utilities beyond the usual normal building services, separate systems for compressed air, gas, vacuum, and distilled water have been provided and piped to the various laboratories throughout the building.

Two independent waste systems—one for laboratory wastes, the other for sanitary wastes—discharge separately to the public sewer, a design provision which eliminates required dilution of laboratory wastes within the building.

Maximum flexibility keynoted the mechanical design program. To permit easy access to laboratory services and piping, there are nine vertical shafts extending from top to bottom of the building. These shafts contain risers for laboratory wastes and vents, hot water, cold water, gas, vacuum, and compressed air. These shafts are provided with removable access panels at each individual laboratory on each of the floors of the building for maintenance purposes.

One of the interesting mechanical features of the installation is the vacuum system. This system has a capacity of 150 cfm of free air and develops a vacuum of 29.75 in. of mercury with a barometer at 30 in. on a closed suction.

Included in the numerous design features is the centrally located combined control and alarm panelboard in the building engineer's office.

Architectural design and planning for the Sloan-Kettering Institute were handled by Skidmore Owings and Merrill. The firm of Guy P. Panero, engineers, was in charge of mechanical design, and construction was by Turner Construction Co.

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Balancing Air Delivery of a System of Manifold Air Diffusers

By George S. Dauphinee* and Peter Argentieri†, New York, N. Y.

SUMMARY—This paper describes a method for balancing multiple air supply outlets (diffusers) in a ventilating system. The method described permits determining *in advance* the damper setting required for each individual outlet so as to apportion the total air delivery among the outlets *in the ratio* intended or required. Its accomplishment depends upon the use of dampers in the outlets which are so designed and calibrated that they can be set for any desired percentage of the full-open outlet capacity. The theory and application of the method are demonstrated by examples.

THE final adjustment and regulation of the air delivery through multiple supply air diffusers or outlets in a ventilating system, for the purpose of bringing their individual air discharge volumes in conformity with those specified, is commonly known as *balancing* the system. At present the method generally adopted is one of trial and error, and is an admittedly costly and unscientific operation.

Regardless of the method employed for balancing, the precision of adjustment will be influenced by the original design and construction of the system, such as the relative proportioning of the distributing ducts and the type and construction of take-offs, air turns and dampers. It is, for example, conceivable that the system design and installation could be so adverse that final regulation to produce the desired or prescribed air distribution would be impossible.

The purpose of this paper is twofold: (*a*) to outline a simple and positive method for balancing multiple air diffusers in a common ventilating system which would also lend itself to standardization, and (*b*) to emphasize the vital importance of proper duct design to insure easy balancing of the system after it is installed.

It is impracticable to so design a duct system that the exact required air volume will be discharged from each respective outlet automatically and without the aid of adjustable dampers. It is further recognized that, unless such dampers are calibrated *functionally*, *i.e.*, to produce a known result directly, tedious trial and error in balancing will be unavoidable. This paper precludes the use of dampers in the ducts to regulate the air delivery through individual outlets and requires the employment of dampers which are part of the outlet and have a known effect on outlet performance.

A system of air outlets is balanced when (*a*) each outlet discharges its specified *percentage* of the total air delivery and (*b*) such total air delivery conforms to that specified. The balancing method to be described consists, therefore, of two steps performed in the following sequence: (1) adjusting the relative air delivery from each air outlet or diffuser *percentage-wise* (without regard to *actual* air delivery) and, (2) checking and, if necessary, adjusting the fan speed so that the proper total actual air delivery is obtained.

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In order to accomplish step 1, the following operating data for each diffuser are required:

(*a*) Capacity factors for determining the volumetric air delivery of any size diffuser from its air outlet velocity.
(*b*) Calibrated damper factors for establishing the damper adjustment of any outlet to produce any desired percentage of its *full open* capacity.

Balancing Procedure

Given a typical installed ventilating system with a multiplicity of air diffusing outlets (diffusers), all dampers should first be fully opened and capacity readings taken for each outlet. For this operation it is not necessary that the fan volume conform to specifications but it is important that it be maintained constant while all readings are made. Next, a calculation should be made to determine the ratio of actual air delivery of each diffuser to the total actual air delivery from all the diffusers. By comparing these ratios with those required by the specifications, the degree of variation in the air *apportionment* among the outlets from that desired will be established and will serve as the basis for damper adjustment of individual outlets. The percentage of damper opening required for each diffuser in order to regain the apportionment specified is then calculated and, using the damper adjustment factors, all dampers (but one—see examples) are set accordingly. After dampers have been set, an air delivery determined for any one diffuser will indicate whether its air delivery is in accordance with or varies from that specified for the respective diffuser. If at variance, it will be known that the capacity of all outlets varies from their specified capacities *in the same degree* and, then, by adjusting the fan speed to produce the capacity required for any one outlet, all other outlets will deliver their respective specified capacities. A final check of several outlets will serve to prove the accuracy of balance.

It is emphasized that the procedure outlined is far simpler than may at first appear, since most of its operations are slide rule computations which can further be facilitated by preparatory tabulation. The manual contribution consists entirely of (1) opening all dampers, (2) determining air delivery from each diffuser, (3) setting dampers and (4) checking the output of several outlets. The method will be clarified by the typical examples which follow. For purposes of simplification only, these examples are arbitrarily limited to five outlets. It should be appreciated that the method and procedure are adaptable to systems with any number of outlets supplied by a common fan as demonstrated by the concluding example showing the results of an actual large-scale balancing operation.

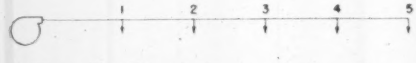

Fig. 1—Air delivery system for Example 1

The diffusers used in all examples contain a built-in sleeve type damper, the function of which is to vary the outlet aperture. It is raised or lowered by means of a central screw operated from below the diffuser. The manufacturer's damper adjustment factors are used for obtaining any desired percentage of the *full open* damper capacity converted to number of screw turns from the full open damper position. These damper factors, therefore, correspond to the ratio of *actual restricted* to *actual full open* air delivery. With this particular type damper the air delivery will be:

$$(\text{cfm}) = V \times F \times \frac{c}{100} \quad \ldots\ldots (1)$$

where

V = outlet velocity, fpm
F = capacity factor
c = percent of full open damper capacity

The outlet could, of course, be designed so that the normal position of the damper is in midway or partially open position permitting adjustment in either the closing or opening direction with corresponding calibration factors. For certain types of dampers, the velocity value will vary directly as the capacity and the air delivery will be simply

$$(\text{cfm}) = V \times F \quad \ldots\ldots (2)$$

Air outlet velocities are determined at the periphery of the diffuser with a standard deflecting vane type anemometer, four readings being taken at points 90 deg apart and averaged. Readings to the nearest 25 fpm are considered sufficiently accurate. The anemometer readings are multiplied by the capacity factor previously established to convert the reading to equivalent air delivery in cubic feet per minute.

Example 1. An air delivery system shown in Fig. 1 has 5 outlets for which the specified air delivery in cubic feet is as follows: No. 1—800, No. 2—800, No. 3—1230, No. 4—1100 and No. 5—560. The total air volume to be delivered is 4490 cfm. Outline procedure for balancing the system.

Solution: The various steps to be taken are given in Table 1.

The tabulation in Table 1 has been purposely elaborated in order to illustrate all operations. For example, Lines c and j are inserted merely to exemplify the establishment of the specified air apportionment because this is, actually, the basis of the method. The function of the values in line G is to establish the outlet to be used as a *base;* the outlet having the lowest percentage of actual delivery volume. This can often be determined merely by inspection without computation of other percentages on this line. Likewise, the values in Line J, while representing the relative air deliveries which would prevail after balancing *if* the observed actual air delivery of the *base* outlet remained constant, are hypothetical since the effect of balancing alters the air delivery of the *base* diffuser. In practice, therefore, the computation of line J is omitted and the percentage of full open damper delivery (line K) obtained directly by dividing values in line H × 100 by values in line G. It is further emphasized that in performing the balancing operation, the tabulation is prepared in advance (omitting lines c, J and j) and the data in

Table 1—Balancing of Air Delivery for *Example 1*

A	Diffuser Location	1	2	3	4	5	Totals
B	Diffuser Size (Inches Neck Dia.)	12	12	14	14	10	
C	Air Volume Specified, cfm	800	800	1230	1100	560	4490
c	Percent of Total Air Specified	17.8	17.8	27.4	24.5	12.5	100
D	Anemometer Reading (fpm) with All Dampers in Full Open Position	2025	1950	1875	1800	1750	
E	Manufacturer's Capacity Factor	0.45	0.45	0.61	0.61	0.31	
F	Actual Air Delivery (cfm) = line E × line D	910	877	1143	1098	543	4571
G	Variation from Specified = line F/line C	1.14	1.10	0.93	1.0	0.97	
H	*Base* Diffuser = Least Value in line G			0.93			
J	cfm Required for Specified Ratio Referred to *Base* = line H × line C	744	744	1143	1022	521	4174
j	Percent of Total line J = line c	17.8	17.8	27.4	24.5	12.5	100
K	Percent of Full Open Damper Delivery Required = $\frac{\text{line J} \times 100}{\text{line F}} = \frac{\text{line H} \times 100}{\text{line G}}$	81.7	84.8	100	93	96	

lines A, B and C are entered thereon from the plans and specifications. Deflecting vane type anemometer readings are then taken for all diffusers at once, entered in line D, and the values in lines F to K inclusive computed. Following this, the dampers are set, likewise at once, in accordance with line K.

It will be observed that, as all dampers are in the open position when determining actual air deliveries, all adjustments must necessarily be in the throttling direction and that, accordingly, the damper in the *base*, or outlet least favored, will always remain fully open, all other diffusers being throttled to the extent necessary to apportion the total air delivery among all diffusers in accordance with specified requirements. It will be observed further that this is accomplished without regard to, and independent of, the actual fan delivery. After the dampers have been adjusted, an anemometer recheck of the *base* diffuser will indicate whether it delivers the required capacity. If not, it will be known that the air delivery of every diffuser of the system varies from the required capacity *in the same ratio* and will be corrected automatically by adjusting the fan delivery accordingly. In *Example 1*, for instance, the velocity reading for the *base* diffuser (in order to comply with specifications in line C) must be 1230/0.61 or 2020 fpm. The following rule and corollary will apply:

Rule—When the damper settings of all the diffusers supplied by a common fan remain constant, any variation in fan delivery will not alter the *percentage* of the total air discharged by each respective diffuser.

Corollary—Any change in the damper settings will alter the air discharge percentages of the individual diffusers.

After dampering and total air delivery adjustments have been completed a spot check of several random diffusers, together with the base diffuser, using Equations 1 or 2 depending on the type of damper used, will suffice to verify the adequacy of balancing. A traverse by Pitot tube or other convenient device may be used to verify total air delivery, if desired. For all practical purposes, a tolerance of ±5 percent, either in individual diffuser or total air delivery may be considered satisfactory since the element of human error in the taking of readings may readily account for a difference of this magnitude.

Example 2. An air delivery system shown in Fig. has 5 outlets, each of which should deliver 600 cfm. Illustrate procedure for *balancing* the system.

Table 2—Balancing of Air Delivery for *Example 2*

A	Diffuser Location	1	2	3	4	5
D	Velocity Reading with All dampers in Full Open Position, fpm	2200	2125	2050	1975	1900
H	*Base* Diffuser = Least Value in line D					1900
K	Per Cent of Full Open Damper Capacity Required = $\frac{\text{Line H x 100}}{\text{Line D}}$	86.4	89.4	92.7	96.2	100

Solution: In *Example 2* it will be noted that the diffusers are all of the same size and are specified to deliver like capacities. Here the balancing computations may be simplified by dispensing with capacity conversion and using outlet velocities directly as indicated in the Table 2:

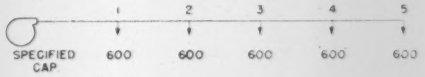

Fig. 2—Air delivery system for Example 2

Assuming capacity factor for the 10 in. diffusers used in the *Example 2* is 0.31, the correct velocity reading of the *base* diffuser No. 5 after balancing should be 600/0.31 or 1935 fpm.

Other similar variations in calculating procedure will be apparent. For instance, in the case of *Example 1*, while the outlets are of different sizes, the neck velocity values bring all sizes into common relation and these values can therefore be used in a simplified procedure. In any event, the forms suggested in Examples 1 and 2 are applicable to all types of systems and would, therefore, lend themselves to standardization.

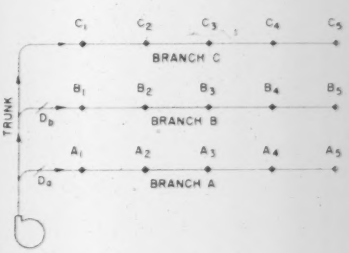

Fig. 3—Air delivery system for Example 3

Example 3. An air delivery system shown in Fig. 3 has 3 branches with 5 outlets on each branch. The required air volume at each outlet is 600 cfm. Outline the procedure for *balancing* the system.

Solution: The system shown in *Example 3* consists of three branches and again entirely in the interest of simplicity, it is assumed that each branch is identical with the single branch used in *Example 2* in number, size and capacity of diffusers. It is further assumed, as may prevail in practice, that the proportioning of trunk and branch ducts alone, without the aid of duct dampers D_a and

D_b, will not produce uniform apportionment of the total air delivery among the three branches without excessive throttling of the most favored diffusers: In balancing a system of this type by the method proposed in this paper, two alternative procedures can be employed. The diffusers in each branch can be balanced separately as in *Example 2* and the *base* (open damper) outlets will be A_b, B_b and C_b respectively. The velocity readings of these *base* diffusers after balancing will, however, vary due to the pressure loss imposed by the trunk duct friction between the branches. The difference in capacity between the three *base* diffusers will likewise correspond to the ratio of difference between the air supply to the respective branches. To correct this difference it is necessary to balance these *base* outlets with respect to each other by the adjustment of duct dampers D_a and D_b. As these dampers are not calibrated, this final balancing operation can only be accomplished by trial and error. However, the required degree of approximate damper adjustment can be computed percentage-wise as given in Table 3 and with this known a minimum amount of adjustment will be required.

Table 3—Balancing of Branch Air Delivery for Example 3

A	Base Diffuser Location	A_b	B_b	C_b
D	Assumed Velocity Reading	1900	1780	1560
H	Base Branch			1560
	Duct Damper	D_a	D_b	
	Percentage of Damper Opening $= \frac{\text{Line H x 100}}{\text{Line D}}$	82	87.7	

The system will be balanced when the outlet velocities of the three *base* diffusers are equivalent. When this has been achieved, any of these diffusers can be read for conformity with the specified air capacity and the fan speed adjusted, if necessary, as already described.

The other, and perhaps more convenient approach to the balancing of *Example 3*, is to first regulate the duct dampers until reasonably uniform outlet velocities are obtained from any three comparable diffusers (one in each branch) and then with these duct damper settings fixed so that they cannot change, to balance all fifteen diffusers as a common system in the manner described for *Example 2*. It will be recognized that the basic method for balancing described is equally applicable to intricate systems involving unequal branches and a multiplicity of diffuser sizes and capacities, requiring only extra steps in computation. Seemingly, systems which are symmetrical and have uniform size diffusers might be balanced on the basis of static pressures within the duct at the diffusers. This is, however, seldom practicable because of the influence of erratic flow patterns.

As already indicated, the authors are of the opinion that special emphasis regarding proper duct design, particularly for air diffusers, is warranted. The original design of a duct distributing system should contemplate the ultimate problem of balancing. The permissible pressure in the duct at the most throttled outlet is, for example, often governed by noise limitation. For extreme quietness this pressure should not exceed 0.25 in. water column. Where noise level is not a factor it may be as high as 0.75 in. water column. Even where noise level is not significant, economy in operation dictates the lowest duct pressure practicable or consistent with duct cost. The design relation between duct pressure and degree of outlet throttling can be expressed by the following Equations 3 and 4:

$$T = 100 - 100\sqrt{\frac{P_1}{P_2}} \quad \ldots\ldots (3)$$

$$P_2 = \frac{P_1}{\left(1 + \frac{T}{100}\right)^2} \quad \ldots\ldots (4)$$

where

P_1 = Minimum duct pressure in inches of water

P_2 = maximum duct pressure in inches of water

T = maximum throttling of individual outlet, percent.

Let

P_1 = 0.25 in. WG and P_2 = 0.75 in. WG

Then

$$T = 100 - 100\sqrt{\frac{0.25}{0.75}} = 100 - 57.7 = 42.3 \text{ percent}$$

Duct Loss = 0.75 — 0.25 = 0.5 in. WG or the equivalent of 500 ft of straight duct based on a loss of 0.1 in. per 100 ft (static regain ignored).

From the preceding it is obvious that the maximum practical extent of throttling, even disregarding noise, will rarely exceed 40 percent. Whenever it is found impracticable to limit the differential pressure across the outlet to that desired the system should be sectionalized with duct or splitter dampers (see *Example 3*). In so doing, the throttling in the high pressure portion of the duct is accomplished in two stages and, as a result, the degree of throttling and consequent pressure differential at the outlets is minimized.

Factors which contribute to pressure loss in duct design have long been evaluated and made available for predicting results. However, the use of circular ceiling air diffusers imposes an additional important and too often ignored factor, namely, the behavior of an air stream entering a circular opening in the bottom of a horizontal rectangular duct. Unless the horizontal air velocity gradient across the duct is symmetrical, the air entering the neck of the diffuser will rotate or swirl rapidly, often creating a vortex and, as a consequence the discharge volume at the prevailing static pressure will be greatly reduced. To regain the specified capacity under such a condition the duct static pressure would have to be correspondingly increased. When, therefore, the duct design is such that the air does not approach the outlet uniformly, it is impossible to predict the duct pressure necessary to obtain the specified capacity since the extent and effect of the swirl are unpredictable. It will further be obvious that, in final balancing, a swirl condition at but a single outlet in the system will necessitate an increase in pressure throughout the entire system and may result in increasing the required differential pressure across the upstream outlets prohibitively.

Air directive devices or so-called air equalizing grids placed in the neck or collar of the diffuser at its

Table 4—Balancing Data for Woolen Mill Air Delivery System[a]

A Diffuser Location	A-1	2	3	4	5	6	7	8
D Velocity Reading	1010	1080	1140	1175	1190	1220	1210	1170
E Capacity Factor	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
F Actual Air Delivery (cfm) = Line D x line E	475	508	536	552	559	573	569	550
G Variation = line F/cfm specified	86.4	92.5	97.5	100	102	104	103	100
H Base (Least value line G)	86.4							
K Percent Actual Delivery = line H x 100/line G	100	93.5	88.5	86	85	82.5	83.5	86.5
L Recheck (New line D Value)	1150							
M Corrected Capacity = line E x line L x K/100	541							
N Error (percent)	—1.3							
A Diffuser Location	B-1	2	3	4	5	6	7	8
D Velocity Reading	1150	1150	1255	1260	1350	1350	1350	1280
E Capacity Factor[b]								
F Actual Air Delivery (cfm) = line D x line E	540	540	590	592	634	634	634	602
G Variation = line F/cfm specified	98.2	98.2	107	108	115	115	115	110
H Base (Least value line G) = Diffuser A-1								
K Percent Actual Delivery = line H x 100/line G	88	88	80.5	80	75	75	75	79
L Recheck (New line D Values)			1475					
M Corrected Capacity = line E x line L x K/100			558					
N Error (percent)			+2					
A Diffuser Location	C-1	2	3	4	5	6	7	8
D Velocity Reading	1155	1270	1275	1275	1310	1355	1380	1210
E Capacity Factor[b]								
F Actual Air Delivery (cfm) = line D x line E	543	597	599	599	616	637	649	569
G Variation = line F/cfm specified	98.6	108	109	109	112	116	118	103
H Base (Least value line G) = Diffuser A-1								
K Percent Actual Delivery = line H x 100/line G	87.5	79.5	79	79	77	74.5	73	83.5
L Recheck (New line D Values)		1460						
M Corrected Capacity = line E x line L x K/100		545						
N Error (percent)		—0.5						
A Diffuser Location	D-1	2	3	4	5	6	7	8
D Velocity Reading	1260	1350	1375	1425	1445	1470	1480	1270
E Capacity Factor[b]						0.47	0.47	0.47
F Actual Air Delivery (cfm) = line D x line E	592	634	646	670	679	691	696	597
G Variation = line F/cfm specified	108	115	118	122	113	126	127	108
H Base (Least value line G) = Diffuser A-1								
K Percent Actual Delivery = line H x 100/line G	80	75	73.5	71	70	68.5	68	79.5
L Recheck (New line D Values)				1600				
M Corrected Capacity = line E x line L x K/100				535				
N Error (percent)				—2.4				
A Diffuser Location	E-1	2	3	4	5	6	7	8
D Velocity Reading	1285	1385	1440	1535	1535	1550	1525	1390
E Capacity Factor[b]								
F Actual Air Delivery (cfm) = line D x line E	604	651	677	721	721	728	717	653
G Variation = line F/cfm specified	110	118	123	131	131	132	130	119
H Base (Least value line G) = Diffuser A-1								
K Percent Actual Delivery = line H x 100/line G	78.5	73	70	66	66	65	66	72.5
L Recheck (New line D Values)							1755	
M Corrected Capacity = line E x line L x K/100							544	
N Error (percent)							—0.8	
A Diffuser Location	F-1	2	3	4	5	6	7	8
D Velocity Reading	1255	1380	1390	1400	1480	1460	1495	1385
E Capacity Factor[b]								
F Actual Air Delivery (cfm) = line D x line E	590	649	653	658	696	686	703	651
G Variation = line F/cfm specified	107	118	119	120	127	125	128	118
H Base (Least value line G) = Diffuser A-1								
K Percent Actual Delivery = line H x 100/line G	80.5	73	72.5	72	68	69	67.5	73
L Recheck (New line D Values)								1610
M Corrected Capacity = line E x line L x K/100								552
N Error (percent)								+0.8
A Diffuser Location	G-1	2	3	4	5	6	7	8
D Velocity Reading	1225	1240	1340	1395	1400	1430	1455	1400
E Capacity Factor[b]								
F Actual Air Delivery (cfm) = line D x line E	576	583	630	657	658	672	684	658
G Variation = line F/cfm specified	105	106	114	119	120	122	124	120
H Base (Least value line G) = Diffuser A-1								
K Percent Actual Delivery = line H x 100/line G	82.5	81.5	75.5	72.5	72	70.5	69.5	72
L Recheck (New line D Values)		1490						
M Corrected Capacity = line E x line L x K/100		570						
N Error (percent)		+4						
A Diffuser Location	H-1	2	3	4	5	6	7	8
D Velocity Reading	1160	1200	1295	1300	1340	1325	1375	1410
E Capacity Factor[b]							0.47	0.47
F Actual Air Delivery (cfm) = line D x line E	545	564	609	611	630	623	646	663
G Variation = line F/cfm specified	99.1	102	111	111	114	113	118	120
H Base (Least value line G) = Diffuser A-1								
K Percent Actual Delivery = line H x 100/line G	87	84	78	77.5	75.5	76	73.5	71.5
L Recheck (New line D Values)	1350							1580
M Corrected Capacity = line E x line L x K/100	552							532
N Error (percent)	+0.8							—3

[a] All diffusers were of 12 in. size (neck diameter). Each outlet was required to deliver 550 cfm. Line F = Total = 39869 cfm. average = 623 cfm. error = +13 percent. Line M = Total (8 outlets) 4929 cfm. average = 547.7, error = (—0.46) percent. [b] As all diffusers are of same size, the capacity factor is constant (0.47).

junction with the bottom of the duct have little effect upon the vortex phenomena and their resultant disadvantages, especially where the outlet is at the end of the duct or branch (and this applies whether the duct is provided with an extension or so-called *cushion head* or not). It is the authors' experience that the only satisfactory and reliable preventive for air entry turbulence is the use of properly designed air directing and straightening vanes in all elbows and branch take-offs to insure symmetrical approach velocity to all diffusers. This caution applies likewise to *fixed throat take-offs* because the design of such take-offs is usually predicated upon the hypothesis of symmetrical air flow across the approach duct. The effect of erratic air patterns produced by take-offs will be noted in the illustration of the balancing of an actual system in the section Application of Method.

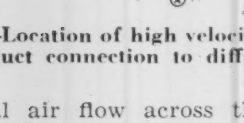

Fig. 4—Location of high velocity point in duct connection to diffuser

Another factor affecting the total pressure calculations which enters into diffuser system duct design is the static pressure required by an outlet collar independent of the resistance of the diffuser itself (see Fig. 4).

Table 5—Delivery Volume by Branches in Cubic Feet Per Minute
(For System shown in Fig. 5)

Diffuser Position	1	2	3	4	5	6	7	8	Totals
Branch A	475	508	536	552	559	573	569	550	4322
Branch B	540	540	590	592	634	634	634	602	4766
Branch C	543	597	599	599	616	637	649	569	4809
Branch D	592	634	646	670	679	691	696	597	5205
Branch E	604	651	677	721	721	728	717	653	5472
Branch F	590	649	653	658	696	686	703	651	5286
Branch G	576	583	630	657	658	672	684	658	5118
Branch H	545	564	609	611	630	623	646	663	4891
Totals	4465	4726	4940	5060	5193	5244	5298	4943	39869

Due to the change in air direction, a high velocity strata at point x is unavoidable and its effect upon duct static pressure may be expressed by Equation 5.

$$P = 2.2 \frac{(V)^2}{(4005)} \quad \ldots\ldots\ldots\ldots (5)$$

where

P = Duct static pressure in inches of water

V = *Mean* neck velocity in feet per minute or $\frac{\text{cfm}}{\text{Neck Area}}$

The value 2.2 remains practically constant for all outlets in a conventional duct system as the ratio of duct static pressure to duct velocity pressure at each outlet will be approximately equal. Unless the diffuser manufacturer's resistance ratings include this factor, it must be allowed for in the calculation of total static pressure.

Application of Method

The following describes the actual procedure in balancing a system in a woolen mill. This installation included 64 diffusers each specified to deliver 550 cfm, and distributed as shown in schematic diagram, Fig. 5 (It should be noted that the only dampers used in balancing this system are those in the individual diffusers.)

Table 4 is the actual tabulation of the balancing data arranged in the form already explained. From this it will be seen that the original maximum extent of unbalance was 35 percent.

Table 5 is a tabulation of the diffusers by branches with the total volume (cfm) of each branch entered in the right-hand column and the total volume (cfm) for the series of diffusers occupying the same relative position in the branches entered at the bottom. These data indicate the effect of duct friction loss. As would be expected, the air delivery through the branches farthest from the fan is less than through branches nearer the fan. Likewise, the diffusers at the far end of the branches deliver less air than those at the near end. The exceptions in this instance are those diffusers close to the branch take-

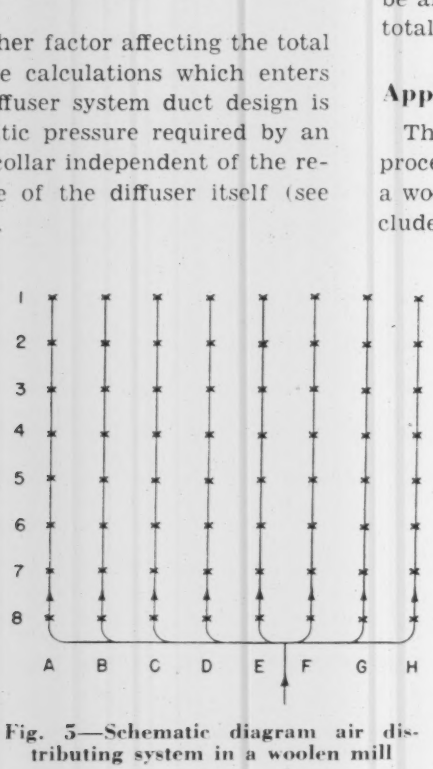

Fig. 5—Schematic diagram air distributing system in a woolen mill

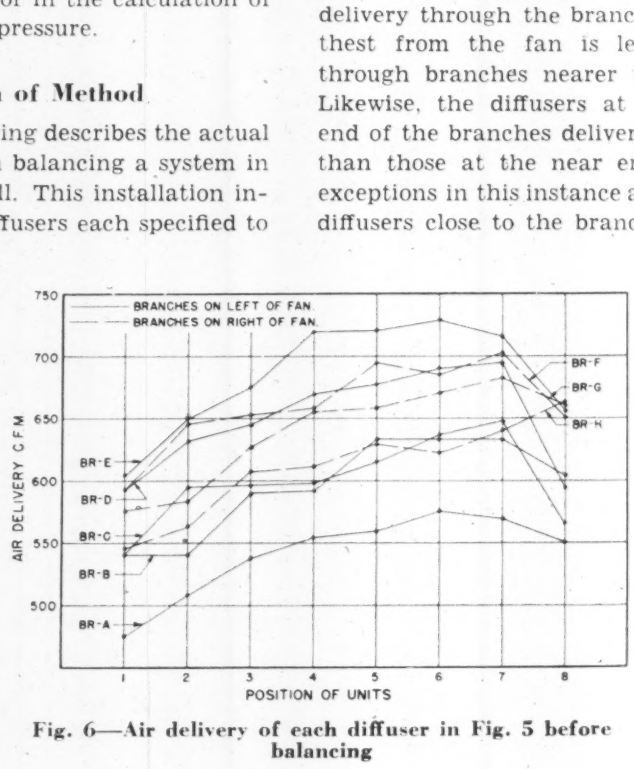

Fig. 6—Air delivery of each diffuser in Fig. 5 before balancing

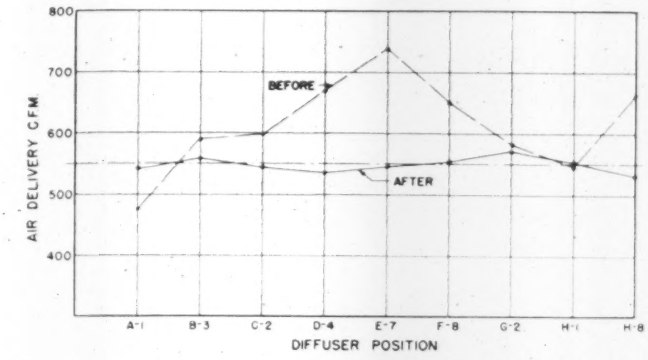

Fig. 7—Air delivery of nine arbitrarily selected diffusers from Fig. 5—after adjustment

offs (except unaccountably in Branch H) which, it will be noted, deliver less air than those next downstream. This variation is due to the swirl imparted to the air by the elbows, an effect already pointed out in preceding text. Thus, the aggregate volume (cfm) of the diffusers in position 8 (Fig. 5) which are located immediately beyond the take-offs is 4943 cfm while the aggregate volume of the outlets in position 7 where the air flow has smoothed out, is 5298. From position 6 to the end of the ducts the air delivery decreases consistently as affected by duct friction loss. The total volume (cfm) delivered by the system before balancing was 39,869 or 13.3 percent higher than specified.

Fig. 6 shows the volume (cfm) delivered by each diffuser in any given branch and is simply a visual representation of the tabulation, Table 5.

After damper adjustments were completed, check readings of approximately one in every eight diffusers were made to confirm that the system was balanced. Reference to Table 4 will reveal that, after balancing, the maximum unbalance (extreme difference in air delivery between any two individual diffusers) was 7 percent and well within the tolerance of ± 5 percent considered acceptable. Also, the average air delivery of the nine diffusers rechecked was 547.6 cfm per diffuser, indicating that the system as a whole was approximately 0.5 percent under capacity, a discrepancy too slight to warrant adjustment of the fan speed.

Fig. 7 is a plot of the delivery characteristic of the nine diffusers rechecked, before and after balancing, and demonstrates the degree of balance achieved directly in a single adjustment.

Referring to the simplicity of the balancing method described in this paper, it may be mentioned that the balancing of this system, including desk and ladder operations, required but 24 man hours.

In conclusion, the authors wish to stress that the data presented in this paper are intended to be introductory rather than conclusive and particularly that investigation of the possible extent of error inherent in the method described is suggested as a suitable project for ASHVE research.

SOUTHERN INDUSTRIAL CONFERENCE

Atlanta, Ga., will be the scene of the Southern Industrial Conference on Machinery and Metals to be held April 26, 27 and 28th. The Conference is sponsored by the *American Society for Metals, American Society of Tool Engineers* and the *Society for the Advancement of Management.*

The latest developments for industry will be exhibited at an exposition to be held in conjunction with the conference.

BUILDING CODES SURVEYED

The housing shortage in the United States has emphasized two problems which pertain to building codes: (1) the present status of building codes, and (2) the relation of existing codes to the rate of construction.

The Bureau of Standards at Washington, through its Building Technology Division, recently undertook a study of local building codes and building regulations. The following conclusions are the result:

(1) A considerable number of codes have not been revised recently;

(2) Although some cities have amended their building codes, most amendments tend to be minor;

(3) Twenty-nine percent of the municipalities have no type of building regulation;

(4) Greater uniformity in codes is necessary among the cities throughout the nation.

With regard to housing, it was stated that the cost of dwellings is determined by more than rising costs of material and labor. An equally important element is the trend for Americans to demand more expensive housing. Such housing includes central heating, extensive plumbing, comfort conditioning and electrical installations capable of handling heavy loads for appliances.

The Bureau of Standards indicates the need for more research, testing, and evaluation of codes and building construction, and also points out that the housing shortage is more than a post-war phenomenon. The shortage has been growing, according to the Bureau, throughout the last 25 years.

Material on building technology, from small homes to bridges, dams and skyscrapers, has been compiled by the Bureau and is available in publications and reports.

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Performance of Heating Panel Studied*

DURING the last half of 1947 the Committee on Research initiated a comprehensive research program on panel heating. The Technical Advisory Committee on Panel Heating and Cooling organized Groups A B, and D, and the Laboratory was instructed to proceed with part A which covers heat transfer within and behind the panel.

At this time last year, the Laboratory had completed a critical analysis of the literature on panel heating, test methods and procedures had been approved by the Committee, and equipment was being assembled.

The first slab was poured on March 3, 1948. Fig. 1 shows the form for this slab with nonferrous tubes in place. The tanks and pumps in the background are for conditioning and circulating water through the panel and absorbers. Rotameters for metering the flow through the absorber circuits may be seen on the left wall.

*Progress Report, Technical Advisory Committee on Panel Heating and Cooling. *Group A—Heat Distribution Within and Behind the Panel.*

Before the concrete was poured, the grid of thermocouples and their supporting framework were installed in the form (Fig. 2). The first slab has $\frac{7}{8}$ in. O.D. nonferrous tubes 4 in. on center. The depth of concrete cover over the tubes is $3\frac{1}{2}$ in. on one side and 5 in. on the other.

The method of testing is as follows: The slab under test is placed between two absorbers (Fig. 3). The back of each absorber consists of a refrigeration plate through which water at any desired temperature can be circulated. The center test section of the absorber is exactly 4 ft square and is surrounded by guard sections by means of which edge losses can be controlled. Heat pickup in the absorber is measured by heat flow meters on the panel side of the refrigeration plates, and can be checked by determining the quantity of water flowing, and its temperature rise.

Fig. 4 shows the arrangement of slab, absorbers, and accessories while tests are in progress. This picture was taken recently while the effect of insulation was being studied.

Slab No. 2 was poured in November, (see Fig. 5) and has nonferrous tubes of the same size and spacing as slab No. 1. However, the depths of cover on this panel are $1\frac{1}{2}$ in. and $2\frac{1}{2}$ in. The location of surface thermocouples may be seen in this figure. This pattern has been used on both sides of the two slabs.

At the present time, warm water is being circulated through the tubes of slab No. 2 to hasten the drying of the concrete. Trouble was experienced in early tests of the first slab because of moisture which was released from the concrete. Tubes of silica gel were inserted under the absorbers to relieve the difficulty and are still being used to prevent possible condensation on the cool absorber surface.

Series of Tests Completed

Although progress on this project during the first year has not been as rapid as was originally

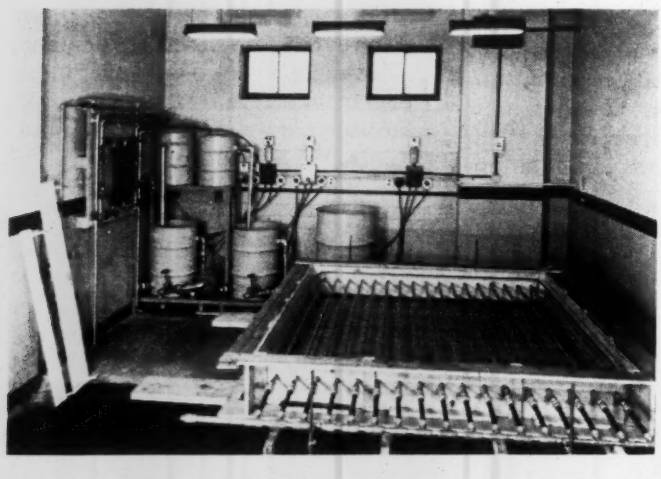

Fig. 1—Form for slab No. 1 with water conditioning and circulating equipment in background

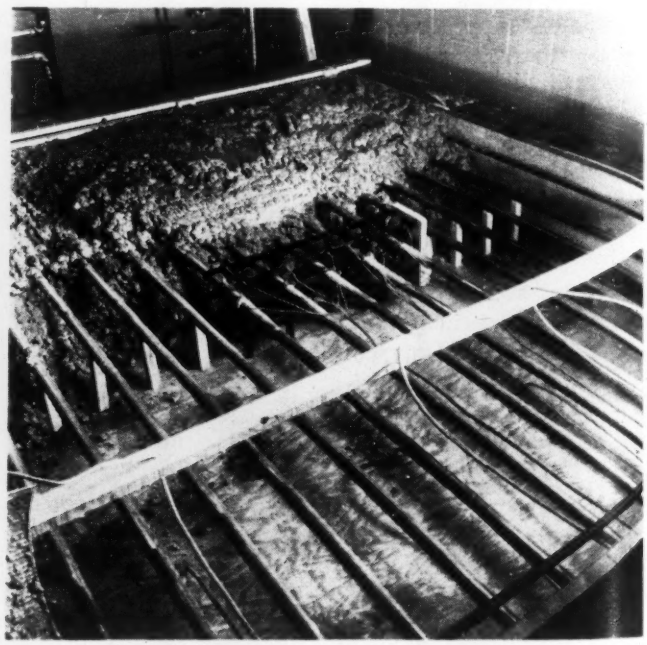

Fig. 2—View showing thermocouple grid for slab No. 1, taken while pouring

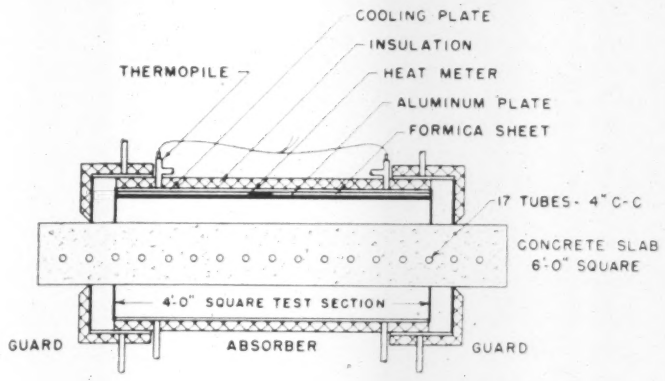

Fig. 3—Sectional view of slab and absorbers

hoped for, work is proceeding satisfactorily. Because of the large heat capacity of slab No. 1, from 8 to 12 hours are required for it to reach equilibrium after any change in test conditions. Tests are therefore limited to one a day. Tests with both surfaces bare have been completed for 4, 8, 12, and 16 in. tube spacings, for various water temperatures and for various heat emissions from the two sides of the slab. At present, another series of tests is nearly completed regarding the effect of insulation on the 5 in. cover side of the slab. A third series of tests will be made on the effect of carpet, asphalt tile, and possibly other common floor coverings.

Many times in research work it becomes necessary to develop new methods, equipment, instruments, or procedures of an incidental nature before the main problem can be successfully attacked. For example, it was decided to apply a coating to all thermocouple wire used on this project to make it moisture-proof and to increase its resistance to abrasion. A coating device was therefore designed and constructed which automatically takes wire from one spool, coats and dries it, and winds it onto a second spool in one continuous operation. In this manner, approximately fifteen miles of wire have been double coated.

When the panel heating project was initiated it was hoped that an analytical solution could be found which would materially reduce the number of tests required for part A of the program. Although a member of the mathematics department at Case Institute of Technology was employed to assist in this analytical study, a method has not yet been found for calculating the heat flow in a slab which will check the results obtained by tests, and which is any less time-consuming than the tests themselves.

It was stated earlier that the tubes in the slab are 4 in. apart. To make tests at 8 in., 12 in., and 16 in. centers, some of the tubes were valved off. Under a cooperative agreement a study is being made at Columbia University to determine, by means of the electric analogger, the effect of the idle tubes in a panel. Temperatures taken on the grid of thermocouples buried in the first slab do not reveal any distortion in the isotherms.

Although quantitative results are not yet available, certain trends are becoming evident. One of the most interesting of these is the extent to which heat release from a panel surface is dependent upon the heat loss from the back of the panel.

In Fig. 6 the heat release from one side of a concrete slab at constant temperature difference (tube to surface) is plotted against the release from the other side, for 4 in., 8 in., 12 in., and 16 in. tube spacings. As might be expected the interdependence of heat flow from the two sides increases as tube spacing increases. It may be noted that for slab No. 1 the same heat release from one side may be obtained with

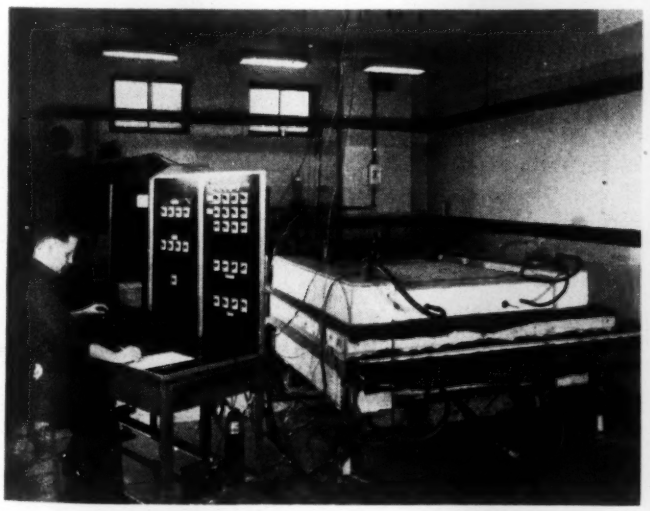

Fig. 4—Slab No. 1 under test

Fig. 5—Slab No. 2 showing preliminary drying system and surface thermocouples

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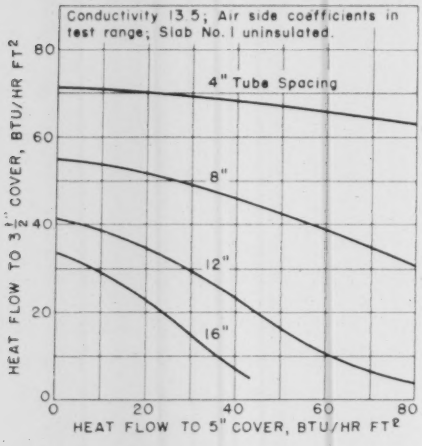


Fig. 6—Effect of back heat loss on panel output at 20 F Δt (tube to surface)

8 in., 12 in., and 16 in. tube centers by controlling the heat flow to the back of the slab.

The next two figures have been prepared to explain this interdependence. Fig. 7 shows the isotherms and heat flow paths in a slab having approximately equal heat flow from the two sides. In this case the pattern for these lines is quite symmetrical about the plane of the tubes.

Fig. 8 shows isotherms and heat flow paths for a slab in which about

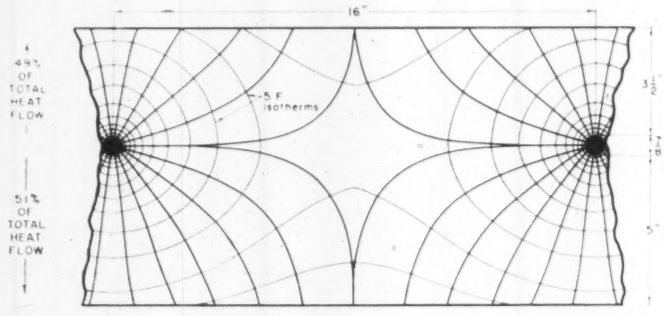


Fig. 7—Heat flow pattern

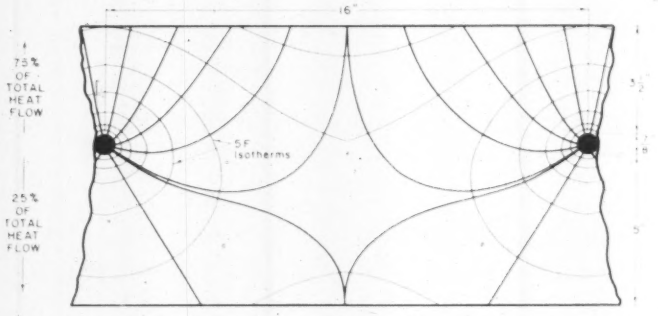


Fig. 8—Heat flow pattern slab No. 1. Both sides of panel exposed. Btu output from top surface same as for Fig. 7

75 percent of the total heat release is from the upper surface of the slab. In this case the pattern of heat flow paths indicates that much of the heat which originally started toward the bottom of the slab has been turned upward. As might be expected from this figure, the temperature of the upper panel surface is much more uniform than in the example shown in the previous figure.

PERSONALS

J. B. Hewett has become associated with the William W. Short Co., Inc., New York, as president and successor to the late William W. Short. Mr. Hewett was formerly sales manager of Anemostat Corp. of America, New York, and has been a member of the ASHVE since 1935.

Appointment of **Robert H. Jacobs** as superintendent of schoolhouse control sales for the Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., has been announced by John E. Haines, vice president of the company's commercial division.

The appointment establishes a new position in the company, Mr. Haines said, and will deal with automatic heating, ventilating and air conditioning control systems for school buildings.

Both Mr. Jacobs and Mr. Haines are members of ASHVE.

L. F. Lawrence, Jr. is a new branch manager for the Minneapolis-Honeywell Regulator Co., Minneapolis. Mr. Lawrence will manage the Charlotte, N. C., office, according to Thomas McDonald, vice president, and succeeds Karl W. Selden, Jr. who has resigned to accept a position with a manufacturer of textile mill equipment. All three men are members of the Society.

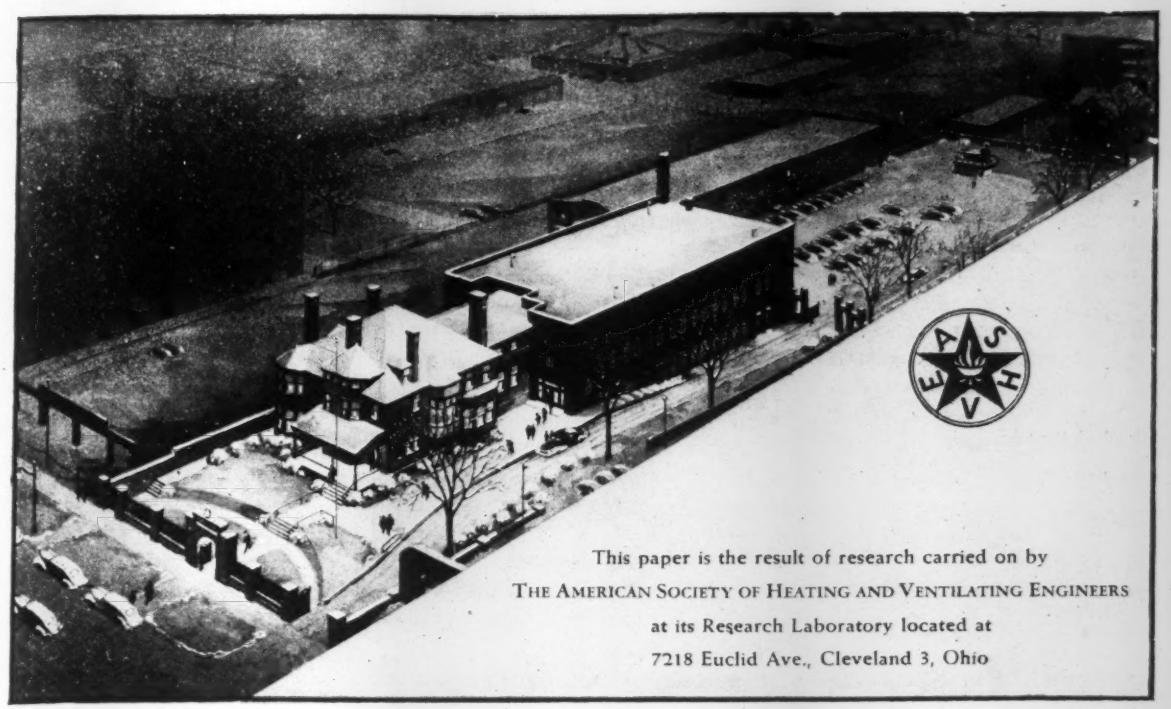
Malcolm N. Todd, for several years division engineer for the Iron Fireman Manufacturing Co. in Canada, has been appointed Canadian division sales manager. He is a member of the ASHVE.

HOME COMFORT EXPOSITION TO BE HELD IN MAY

The 1949 Home Comfort Exposition will be held in Cleveland, Ohio, from May 30 to June 2, 1949, according to an announcement by Walter E. Eynon, general chairman of the convention and exposition committee.

The exposition is being sponsored by the *National Association of Master Plumbers*, of which Mr. Eynon is president. Up to the present time, 99 manufacturers have reserved more than 87 percent of the available booth space, Mr. Eynon said.

Mr. Eynon has been a member of ASHVE since 1943.



This paper is the result of research carried on by
THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
at its Research Laboratory located at
7218 Euclid Ave., Cleveland 3, Ohio

Turbulence—A Fundamental Frontier In Air Distribution

By H. B. Nottage*, Cleveland, Ohio

SUMMARY — Turbulence is introduced as a quantitative factor in air-distribution phenomena. Elementary concepts are presented and representative practical applications are cited. A truly fundamental understanding of the actual mechanisms of turbulence remains an unconquered frontier, although many engineering problems may be mastered through a judicious introduction of convenient empiricisms and careful experimentation.

Introduction and Scope

PROPER air distribution is one of the arts of air conditioning wherein many new data are continually needed to simplify and expedite design work and installation analyses. The general nature of this need in relation to the ASHVE Research Program has been discussed previously[1].

This paper, developed under auspices of the Technical Advisory Committee on Air Distribution[†], presents an introductory discussion of *turbulence* as an air-distribution phenomenon of vital fundamental importance and is one of a long-term series being developed to meet engineering needs for new data and more comprehensive application principles.

The first simple concepts of turbulence, which are important in appreciating the art of air distribution, will be reviewed. Engineering applications will be indicated for duct friction, turbulent diffusion, and free jets.

The Force-Motion Viewpoint

For better understanding of the fluid-flow problems of controlled air distribution, consider the fundamental question of what goes on within a body of air in motion. A small element of air mass is set into motion by forces acting upon it. Any change in the state of motion is brought about by further force action, with an acceleration or deceleration being opposed by the inertial force of the elementary air mass itself. Thus, an engineering approach to the diagnostic study of air distribution may be built about an *analysis of all of the forces which influence air motion*. Data and design methods recognizing such forces, in relation to the independent variables of an installation, will yield *controlled air distribution*.

The main forces which act within a moving body of air under conventional air-conditioning conditions are: (1) static pressure differences; (2) inertial forces (whenever acceleration acts); (3) buoyancy forces (caused by density differences); (4) shear forces (most evident at solid boundary although also very important within fluid body); (5) gravitational attraction

*Research Associate, ASHVE Research Laboratory. Member of ASHVE.
[1]Exponent numerals refer to References.
[†]TAC on Air Distribution: Ernest Szekely, chairman; N. E. Berry, R. M. Conner, S. H. Downs, F. B. Holgate, F. J. Kurth, J. N. Livermore, R. D. Madison, G. E. McElroy, L. G. Miller, D. W. Nelson, W. A. Pownall, G. B. Priester, T. H. Troller.
Presented at the 55th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Chicago, Ill., January 1949.

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(often a negligible effect in air-conditioning systems).

Given definite expressions for each force entering a particular problem, *equations of motion* may be written which, when solved, yield the velocity and acceleration of the fluid body as a function of position and time. This procedure is easy to state but commonly quite difficult to attain because of practical impediments which are:

1. *Turbulent nature of the air motion:* Where turbulence exists, the pressure, velocity and temperature are in a continual state of rapid, random fluctuation which can be so complicated as to defy either exact mathematical expression or direct experimental measurement beyond simple exploratory observations.

2. *Inadequate means of expressing turbulence-dependent forces in terms of simply attainable experimental data:* In order to describe the fluid behavior in the form of equations which can be solved, all forces and turbulent actions need to be related to the primary easily-measurable variables of the fluid motion. Complicated turbulent behavior must be reduced to a relatively simple form of expression. This can be achieved for important practical cases at present only through experimentally-based empiricisms which lead to approximate engineering solutions.

3. *Mathematical obstacles:* While it may be possible to write the fundamental equations of fluid motion in mathematical notation, it is not always possible to solve these equations and thereby establish concise engineering results. Approximations and empiricisms must then be used and are invaluable engineering tools, although often subject to misuse.

Let it be emphasized however, that despite these impediments there have been established many valuable engineering results based upon the simple fundamentals of turbulence. The future will undoubtedly see many more practical advances, for the research incentive is keen, especially in aerodynamic problems.

Elementary Turbulence Concepts and Quantities

Turbulence is the physical phenomenon which takes place within a body of fluid in motion whenever small but finite fluid particles undergo an irregular, violent commotion and agitation which sets in spontaneously as a process of dissipating (degrading) the available‡ energy of directed fluid motion.

Manifestation of turbulent flow is observable in the body of a moving fluid through the erratic paths of small suspended particles and the continual random creation, interaction and destruction (as individually distinguishable entities) of innumerable small eddies. In this condition of flow it is not correct to speak of a certain velocity, pressure, or temperature as existing independent of time at a particular point. Instead, each of the variables of the fluid state must be regarded as undergoing continual and irregular *fluctuations*.

Representation of fluctuating quantities is conveniently accomplished by expressing them as the sum of two magnitudes; a *mean* value (mean with respect to time at a fixed position), and a superposed *fluctuating* component. Adopting capital letters for mean quantities, lower-case letters for fluctuating components, and considering a two-dimensional flow as represented on the xy-plane, instantaneous quantities are written as follows:

Static pressure $= P + p$

Temperature $= T + t$

Velocity, x-direction component, $= U + u$

Velocity, y-direction component, $= V + v$

Each fluctuating quantity varies rapidly at random, may be either positive or negative at any instant, and must necessarily have a mean value of zero.

‡Available energy as used here refers to static pressure and directed kinetic energy.

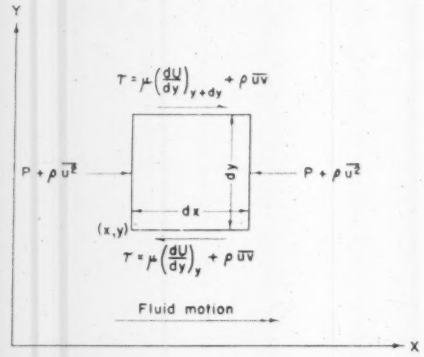

Fig. 1—Forces per unit area acting in the x-direction on an elementary fluid volume in turbulent flow with T, P, and ρ constant and with uniform turbulence conditions

The practical significance of turbulent fluctuations may be demonstrated by considering only the velocity fluctuations in an isothermal, constant-static-pressure, incompressible, unidirectional flow stream, *i.e.*, with $V = 0$, $P =$ constant, $\rho =$ constant and $T =$ constant for all positions.

Picture an elementary lattice volume in the stream of unit length perpendicular to the xy-plane, Fig. 1. For conditions of purely laminar flow, when turbulence is not present, the forces per unit area acting in the x-direction are:

1. A static pressure which is the same on both the x and $(x + dx)$ faces.

2. A viscous shear stress which is written as

$$(\tau_v)_y = \mu\left(\frac{dU}{dy}\right)_y$$

or

$$(\tau_v)_{y+dy} = \mu\left(\frac{dU}{dy}\right)_{y+dy} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

When turbulence exists the velocity fluctuations produce *additional stresses*, commonly called the *virtual stresses of turbulence*. For the simple condition in which these turbulence stress components are the same at all points in the region considered, the additional stress magnitudes acting in the x-direction in Fig. 1 are:

1. A pressure caused by the u fluctuations.

$$\overline{p} = \rho\overline{u^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

2. A shear stress caused by the transfer of the u-fluctuation momentum in the y-direction through the particle-transporting action of the v fluctuations.

$$\tau_t = -\rho\overline{uv} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The bar over a product denotes a mean value and ρ is the fluid density [mass density, (pound) (second)^2/(feet)^4].

The total stresses for turbulent flow are the sum of the turbulent and viscous effects, as indicated in Fig. 1.

The development of the basic ideas continues with the quantities, *intensity*, *correlation*, and *scale*, and with the condition of *isotropic turbulence*.

1. *Intensity*: Although the mean value of u is zero because, on the average,

the positive and negative fluctuations cancel each other, the mean square fluctuating velocity, $\overline{u^2}$, is always positive and finite. The mean x-direction kinetic energy of the turbulent fluctuations is measured by $\overline{u^2}$; and $\overline{u^2}$ thus serves to indicate the *violence* of the turbulence. The intensity of the turbulent velocity fluctuations is defined as

$$\text{Intensity} = \frac{\sqrt{\overline{u^2}}}{U} \quad \ldots\ldots\ldots\ldots (4)$$

Intensity magnitudes encountered in practice vary from a small fraction of a percent to as much as 20 percent or so.

2. *Correlation:* The condition that the mean product of the two fluctuating velocities at some point in the fluid, $\overline{uv}$, should be other than zero is that a correlation should exist between them. This correlation, R, is a statistical quantity defined as

$$R = \frac{\overline{uv}}{\sqrt{\overline{u^2}}\sqrt{\overline{v_2}}} \quad \ldots\ldots\ldots\ldots (5)$$

The magnitude of R may vary between 0 and 1, inclusive. If $R = 0$, then the fluctuations u and v are *completely unrelated*. If $R = 1$, then u and v are *uniquely* interrelated; that is, for each and every value of one of the quantities there is a corresponding single definite value of the other. If R has some intermediate magnitude, it means that for some particular value of one quantity the other quantity will have only a *most probable* value with the chance being that its value may scatter within a considerable range above or below this *most probable* value. The smaller the magnitude of R, the greater is the range of possible scatter.

Fig. 2 illustrates the idea of a correlation. Imagine that *corresponding instantaneous values* of u and v were to be plotted. Sketch (a) shows a condition of no correlation, sketch (b) shows a condition of $R = 1$, and sketch (c) shows a condition corresponding to an intermediate magnitude of R.

3. *Scale:* Specification of a state of turbulence requires some relative measure of the size of the small eddies which characterize the conditions prevailing. Different definitions of scale are possible, and each has its use. The one to be presented here is of particular value in the analysis of turbulent diffusion.

Fluid particles traverse continuous paths in turbulent motion. Imagine some one particle to be followed along its path in a region of uniform mean velocity U and uniform intensity $\frac{\sqrt{\overline{u^2}}}{U}$ and express the extent to which its fluctuating velocity component u_s, existing after a time interval s from some initial instant when $u = u_o$, is dependent upon u_o in terms of the correlation R_s defined as

$$R_s = \frac{\overline{u_o u_s}}{\overline{u^2}} \quad \ldots\ldots\ldots\ldots (6)$$

where

$\overline{u^2} = \overline{u_o^2} = \overline{u_s^2}$ by the postulate of uniform intensity.

At the initial instant, of course, $R_s = 1$; and as the time interval s grows R_s approaches its ultimate magnitude of zero. When $R_s = 0$ it means that the particle's fluctuating velocity then is no longer in any way dependent upon u_o. Since the motions of all particles which pass through a turbulence eddy or whirl must have some sort of characteristic continuity, one possible *scale* of the turbulence would be a probability-weighted mean distance of particle travel during the time interval required for R_s to become zero. Thus, define the scale l_s as

$$l_s = \sqrt{\overline{u^2}} \int_0^{s_o} R_s \, ds \quad \ldots\ldots\ldots\ldots (7)$$

Where the upper limit s_o is the time interval required for R_s to become zero (and for $s > s_o$, $R_s = 0$ at all times). An equivalent expression is then

$$l_s = \sqrt{\overline{u^2}} \int_0^{\infty} R_s \, ds \quad \ldots\ldots\ldots\ldots (8)$$

Scale magnitudes are usually less than an inch in engineering problems, although a phenomenon such as atmospheric turbulence may have a quite large scale.

4. *Isotropic Turbulence:* In the most general state of turbulence the scales and intensities have different magnitudes in different directions at any point in the fluid and are further different between any two points in the same direction. This case is at present too complicated to permit mathematical analysis to obtain practical results, and even an experimental study of such fluctuations involves a tremendous, almost prohibitive, amount of instrumentation detail. By far the greatest amount of factual knowledge and analyses to date have been established for the simplest condition of turbulence, called *isotropic* turbulence.

In isotropic turbulence the intensity and scales have the same magnitudes in all directions at any one point; hence a single specification or a single measurement of these quantities completely determines the characteristics of the turbulence at the point being considered. Strict isotropy requires (as a consequence of the defining conditions) that the correlation R, Equation 5, be zero, which means that the turbulent shear stress of Fig. 1 must be zero and that all fluctuations are completely at random.

Turbulence in engineering flow systems, strictly speaking, is almost always nonisotropic; but nonisotropic turbulence has a strong natural tendency to become isotropic if interferences such as solid boundaries, high gradients of pressure, obstacles, and like effects are minimized or far removed from the location being considered. Hence, as a practical approximation, the theories of isotropic turbulence have been extended to the utmost for engineering expediency.[2]

Some Engineering Empiricisms

Among the many empiricisms which have been variously considered to simplify turbulence as a *practical* problem, only a few of the more familiar ones will be mentioned here. Despite fundamental weaknesses, these have been of engineering utility. To be considered are the *eddy viscosity*, *eddy conductivity*, *eddy diffusivity*, and a

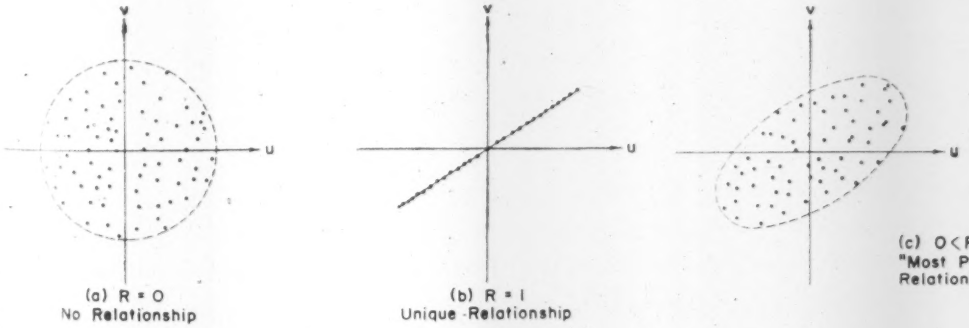

Fig. 2 — Illustration of the concept of a correlation between the fluctuating quantities u and v

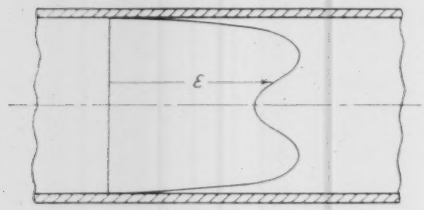

Fig. 3—Form of the eddy-viscosity variation across a circular pipe in fully-developed turbulent flow

kind of scale known as the *mixing length*.

1. *Eddy viscosity*: While it is a fundamental accomplishment to express the virtual shear stress due to turbulence (Fig. 1) as

$$\tau_t = -\rho \overline{uv},$$

engineering problems cannot be solved until the product $\overline{uv}$ is somehow expressed in terms of the independent variables of the flow. An early proposal for doing this was to assume that turbulence had an effect similar to an increase in the magnitude of the absolute viscosity, μ. Thus an *eddy viscosity*, ϵ, was invented which was to satisfy the defining equation,

$$\tau_t = \rho\varepsilon \frac{dU}{dy} \quad \ldots\ldots\ldots\ldots\ldots (9)$$

The total shear stress then was expressed in the form

$$\frac{\tau}{\rho} = (\nu + \varepsilon) \frac{dU}{dy} \quad \ldots\ldots\ldots (10)$$

where

$\nu = \mu/\rho$, the kinematic viscosity of the fluid.

Extensive experimental experience was needed to validate this step. If ϵ proved to be a definite characteristic of each type of flow and to be a simple function of the independent variables involved, then it could be accepted as a sort of *property* of turbulent flow. Accumulated evidence has served to disprove this broad hope, however, and the eddy viscosity has become an empiricism which may be convenient but can be used only where data have been established to predetermine its magnitude.[3]

The typical variation of eddy viscosity across a pipe diameter for fully developed turbulent flow is sketched in Fig. 3. The maxima there shown at a position slightly less than half a pipe radius out from the wall indicate the region of most violent turbulent commotion and eddy-mixing action. Recognition of this is important when analyzing turbulent heat or mass transfer in pipes, for example.

2. *Eddy conductivity and eddy diffusivity*: The virtual shear stresses of turbulence arise as a consequence of the turbulent transfer of fluid-particle momentum across surfaces within a fluid body. In a similar manner, turbulence has a strong influence upon heat transfer or mass transfer (diffusion) within a fluid body, and the empiricism of the eddy viscosity has been paralleled by the invention of *eddy* quantities for turbulent heat and mass transfer.

Consider a laminar fluid flow in the x-direction. The rate of heat transfer across the stream, in the y-direction, may be written as

$$\left(\frac{q}{A}\right)_v = -k \frac{dT}{dy},$$

Btu per (hr) (sq ft) ..... (11)

where k is the thermal conductivity and (dT/dy) is the temperature gradient.

Next consider that the stream becomes turbulent and define an *eddy conductivity*, β, by the relation

$$\left(\frac{q}{A}\right) = -(k + \beta) \frac{dT}{dy},$$

Btu per (hr) (sq ft) ..... (12)

For mass transfer, imagine that some substance is diffusing across the laminar stream. The rate of diffusing mass flow is

$$\left(\frac{m}{A}\right)_v = -\eta \frac{dC}{dy},$$

lb per (hr) (sq ft) ..... (13)

where η is the diffusivity for the substance and the fluid concerned and (dC/dy) is the concentration gradient for the diffusing substance (concentration is expressed as the pounds of diffusing substance per cubic foot of fluid).

In turbulent flow, define an *eddy diffusivity*, D, by the relation

$$\left(\frac{m}{A}\right) = -(\eta + D) \frac{dC}{dy},$$

lb per (hr) (sq ft) ..... (14)

Generally in fully-developed turbulence the viscous terms are negligibly small in comparison to the *eddy* quantities in Equations 10, 12, and 14, so that the turbulent processes can be described directly as:

Momentum transfer,

$$\tau/\rho = \varepsilon \frac{dU}{dy} \quad \ldots\ldots\ldots\ldots (15)$$

Heat transfer,

$$q/A = -\beta \frac{dT}{dy} \quad \ldots\ldots\ldots\ldots (16)$$

Mass transfer,

$$m/A = -D \frac{dC}{dy} \quad \ldots\ldots\ldots\ldots (17)$$

3. *Analogy approximation interrelating the eddy quantities*: Engineering problems are frequently expedited where data are otherwise lacking, by the use of some sort of an analogy between momentum, heat, and/or mass transfer. If the turbulence mechanisms of these three phenomena were similar

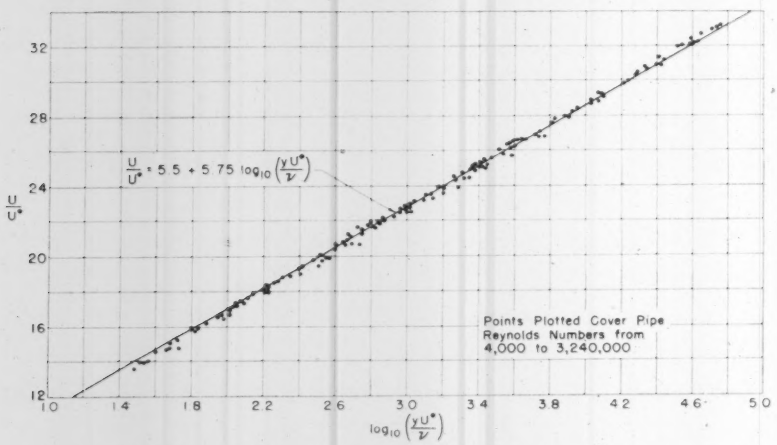
$\frac{U}{U^*} = 5.5 + 5.75 \log_{10}\left(\frac{yU^*}{\nu}\right)$
Points Plotted Cover Pipe Reynolds Numbers from 4,000 to 3,240,000
$\frac{U}{U^*}$
$\log_{10}\left(\frac{yU^*}{\nu}\right)$

Fig. 4—Nikuradse's data on the velocity distribution for turbulent flow in smooth pipes as employed to establish the velocity-distribution function of Equation 29

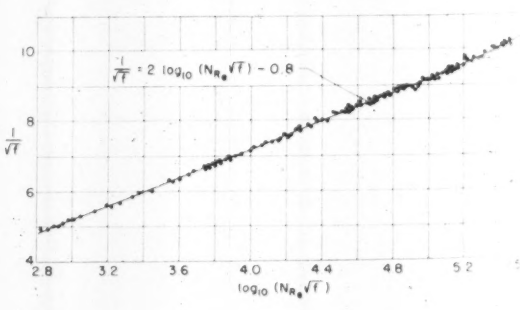

Fig. 5—Nikuradse's data on friction factors for turbulent flow in smooth pipes as employed to establish the function of Equation 30

which is in many simple cases a workable although inexact approximation to be assumed, then Equations 15, 16 and 17 could be further interrelated. The assumption would be expressed as

$$\epsilon \cong \frac{\beta}{3600\rho\, c_p\, g} D, \text{ sq ft/sec} \quad \ldots\ldots\ldots\ldots\ldots (18)$$

where $g = 32.2$ ft/(sec)^2 and 3600 is a time-unit conversion, hours to seconds.

Successful practical applications of Equation 18 have been made.[4]

4. *The mixing length*: An early turbulence empiricism which received considerable attention for a time was the so-called *mixing length*. A simple development of this idea will be given, following Prandtl.[5]

Consider again a turbulent flow parallel to the x-axis with the mean velocity U a function of y only. The shearing stress on a horizontal plane in the direction of U, neglecting ν compared to ϵ, is of magnitude

$$\tau = \rho\, \overline{uv} = \rho\, \epsilon\, \frac{dU}{dy} \quad \ldots\ldots\ldots\ldots (19)$$

This shows that (τ/ρ) is dimensionally the square of a velocity; let this velocity be

$$U_* = \sqrt{\frac{\tau}{\rho}} = \sqrt{\overline{uv}} \quad \ldots\ldots\ldots\ldots (20)$$

(where positive magnitudes are always understood under the square root signs). The eddy viscosity ϵ has the dimensions (length $\times$ velocity). Assume that U_* is this latter velocity, for it is the most significant one directly associated with the turbulence, and introduce an arbitrary length l to write

$$\epsilon = l\, U_* \quad \ldots\ldots\ldots\ldots (21)$$

Substituting Equation 21 and the relation $\tau = \rho\, U_*^2$ into Equation 19, there follows

$$U_* = l\, \frac{dU}{dy} \quad \ldots\ldots\ldots\ldots (22)$$

The eddy viscosity can alternatively be expressed

$$\epsilon = l^2\, \frac{dU}{dy} \quad \ldots\ldots\ldots\ldots (23)$$

Equation 19 for the shear stress then can be written**

$$\tau = \rho\, l^2 \left(\frac{dU}{dy}\right)^2 \quad \ldots\ldots\ldots\ldots (24)$$

** Observing that the sign τ must change as the sign of (dU/dy) changes, a mathematically rigorous expression is

$$\tau = \rho l^2 \left|\frac{dU}{dy}\right| \left(\frac{dU}{dy}\right)$$

The quantity l is called the *mixing length*; its advantage is merely its simple definition, and it is not a truly fundamental quantity. Its use may be empirically helpful for simple flow systems wherein both the shear stress and the mean-velocity distribution are known to follow simple formulas, for then l will be some simple function of position and of the flow variables. Wherever l is known in simple form, solution of the equations of motion for turbulent flow is facilitated.

The name *mixing length* arose from another method of derivation wherein turbulent fluid entities are pictured as producing a shear stress by *shooting* back and forth between adjacent *layers* of fluid; and the mean distance of such travel is then l. From this latter aspect, l is a sort of *scale* of the turbulence.

Brief Application Examples

Friction in Ducts and Pipes

Currently recommended duct-friction factors[6] were established from a systematic empirical treatment of turbulent-flow data. The development will be briefed here for smooth round ducts.

First solve Equation 24 to obtain an expression for the mean velocity, U, as a function of radial position. Let y denote the distance from the duct wall measured radially *inward*. Then:

1. By dimensional reasoning, set the mixing length proportional to some dimension characterizing the turbulence. The distance y is the simplest one, so take

$$l = K_1\, y \quad \ldots\ldots\ldots\ldots (25)$$

2. In pipe flow the shear stress, τ, is zero on the axis and increases linearly along the radius to reach a maximum, τ_o, at the wall; *i.e.*,

$$\frac{\tau}{\tau_o} = 1 - \frac{y}{a_o} \quad \ldots\ldots\ldots\ldots (26)$$

where

a_o = the pipe radius.

3. Upon substituting Equations 25 and 26 into 24 and integrating to obtain a relation between U and y, there is obtained a velocity-distribution equation which can be tested by experimental data.[5, 7] It so happens however, serving as a demonstration of the peculiarities of empiricisms, that the result of these steps is in poorer agreement with experiment than is the result of assuming that $\tau = \tau_o$ throughout the pipe and then solving for the velocity distribution. This latter procedure yields Prandtl's famous logarithmic velocity-distribution law,

$$\frac{U_c - U}{U^*} = \frac{l}{K_1} \ln_e \left(\frac{a_o}{y}\right) \quad \ldots\ldots (27)$$

where

$$U^* = \sqrt{\frac{\tau_o}{\rho}}$$

U_c = mean velocity at the pipe axis

This form of expression agrees very well with the velocity-distribution data of Nikuradse,[7] although its *derivation* is not fundamentally rigorous. But any equation which represents engineering data over an established range has practical value no matter how it may be obtained, and proceeding from the demonstrated utility of Equation 27 further useful relationships are attainable. Note that U^* and the conventional friction factor,[6] f, are related:

$$U^* = \sqrt{\frac{\tau_o}{\rho}} = U_{mean} \sqrt{\frac{f}{8}} \quad \ldots\ldots\ldots\ldots (28)$$

where

U_{mean} is the mean fluid velocity over the pipe cross section.

Final equations of *great practical importance*, with empirical constants determined from Nikuradse's data for turbulent flow in smooth pipes, are the following:

The *velocity distribution:*

$$\frac{U}{U^*} = 5.5 + 5.75 \log_{10}\left(\frac{y\, U^*}{\nu}\right) \quad \ldots\ldots\ldots\ldots (29)$$

The *friction-factor relationship:*

$$\frac{1}{\sqrt{f}} = 2 \log_{10} (N_{Re} \sqrt{f}) - 0.8 \quad \ldots\ldots\ldots\ldots (30)$$

Figs. 4 and 5 show how Equations 29 and 30 represent Nikuradse's data. The velocity distribution* refers only to the turbulent *core*; near the wall viscous effects become important and the flow pattern changes. Other similar relationships are applicable to rough pipes[7].

The preceding material is but one example of the many ways in which turbulence empiricisms have been

*The validity of the Nikuradse data, in the immediate vicinity of the pipe wall, has recently been questioned, but the region in question has been excluded from the range of Fig. 5.

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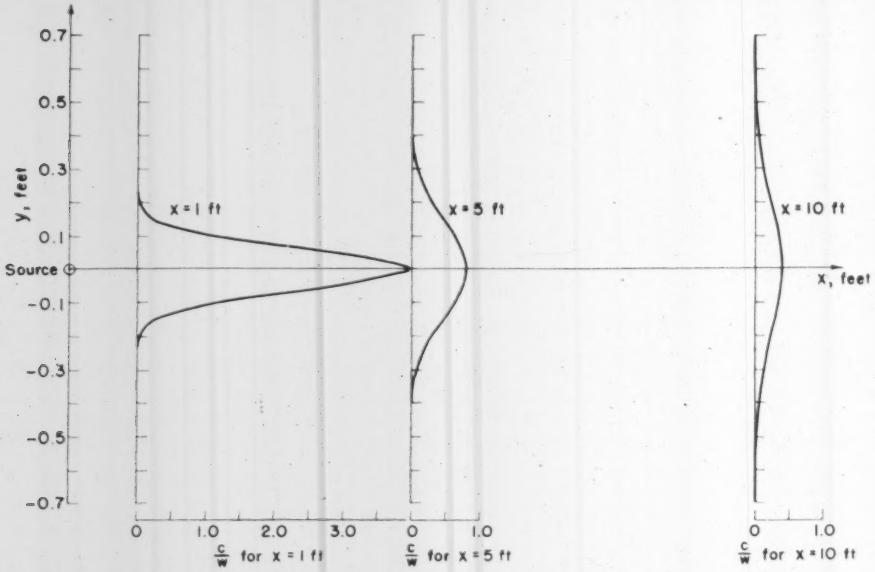

Fig. 6—Relative distribution of dust-particle concentration downstream from a point source (Equation 33)

of great practical utility to the engineer in treating turbulent flow.

Turbulent Diffusion

The processes of turbulent diffusion whereby mass or heat spreads across a turbulent stream are of wide technical importance. Turbulent diffusion in substantially isotropic streams, of cross section large enough to permit instrumentation without distorting the flow, can be studied by relatively simple methods; and this fact has been used in obtaining measurements of intensity and scale for application to various practical problems[8,9,10].

One little-investigated application to an air-conditioning problem would be the treatment of dust transport and deposit in large ducts according to the theory of sediment transport in turbulent streams[11]. A very simple related problem, suitable as a brief illustration, would be the spread of dust particles introduced in the air stream of a large duct at a uniform rate from a *point* source. The equation of turbulent diffusion will be given for this case, neglecting any gravitational settling of particles, and applicable under conditions where: (1) the mean velocity U is constant, (2) the turbulence is at least approximately isotropic, (3) the intensity and scale of the turbulence are constant (or, alternatively, the eddy diffusivity is constant), (4) the dust particles have a small enough inertia not to be thrown out of the turbulence eddies, and (5) the distance downstream from the source is greater than l_s. The dust particle concentration[12] as a function of the position coordinates (x,y), with the source at the origin, and letting

$$L = \sqrt{x^2 + y^2}, \text{ is}$$

$$C = \frac{w}{4\pi DL} e^{\frac{U}{2D}(L - x)} \quad \ldots\ldots (31)$$

where

C = dust particle concentration in parts by weight per unit volume

w = the source emission, dust-particle parts by weight per second

D = eddy diffusivity, square feet per second.

When $(L - x)$ is a small quantity, the sagitta formula gives

$$L - x = \frac{y^2}{2x} \quad \ldots\ldots (32)$$

A corresponding form of Equation 31 is

$$\frac{C}{w} = \frac{1}{4\pi D\left(x + \frac{y^2}{2x}\right)} e^{-\frac{U}{4D}\frac{y^2}{x}} \quad \ldots\ldots (33)$$

Fig. 6 demonstrates Equation 33 for $U = 10$ ft per second and $D = 0.02$ sq ft per second.

Phenomena of turbulent diffusion are both abundant and important; smoke dissipation, exhaling of breath, sediment transport in streams, and the dispersion of water-droplet mists are examples.

Free Jets

So long as workable formulations of turbulence phenomena require empiricisms, the analysis of turbulent jet behavior will also require some sort of empiricism. Some of the component features of jet behavior are predictable however on the basis of present knowledge. For example, theory[13] predicts the course of the centerline jet velocity as follows:

1. For a two-dimensional isothermal plane jet (*e.g.*, jet from very long and narrow slot), when a condition of fully-developed turbulence has been reached the centerline velocity should fall off in proportion to the inverse of the square root of the distance from the source.

2. For a cylindrical isothermal jet when a condition of fully-developed turbulence has been reached the centerline velocity should fall off in proportion to the inverse of the distance from the source.

These predictions were checked against experimental data by Tuve and Priester[14]. For discharge into a large free space condition 1 was not attained for jets from long narrow slots with aspect ratios as high as 128:1. Slots from the rectangular outlets tested all tended towards a circular cross section at sufficient distances from the outlet. These authors also found that condition 2 was only approximately followed by their data; instead of direct proportionality being maintained to the end of the jet, the observed proportionality constant decreased in magnitude as the end of the jet was approached. Interpretation can only be variously surmised, but the basic phenomenon to be better understood is *turbulence*.

The recent data of Albertson et al[15], on the other hand, show good agreement with both conditions 1 and 2. Two-dimensional plane jets were formed from slots of aspect ratios 288:1 and greater, with the jets discharging between two parallel walls set perpendicular to the plane of the slot outlet and perpendicular to the long side of the rectangular slot at the slot ends. This condition typifies a situation occasionally met

in air-conditioning practice. The equation given for the two-dimensional jet (with rounded approach to the slot) was

$$\frac{U_{max}}{U_o} = 2.28\sqrt{\frac{b_o}{x}}, \quad \text{for } \frac{x}{b_o} > 6, \qquad \ldots\ldots\ldots\ldots\ldots\ldots (34)$$

where

U_{max} = the centerline jet velocity,
U_o = the initial jet velocity,
b_o = the slot width in feet,
x = the normal distance from the outlet in feet.

Equation 34 was established for initial velocities from 2400 to 10,800 fpm, and the lowest jet velocity measured was 100 fpm.

The equation given by Albertson et al[15] for cylindrical jets was

$$\frac{U_{max}}{U_o} = 6.2\frac{d_o}{x}, \text{ for } \frac{x}{d_o} > 7, \qquad \ldots\ldots\ldots\ldots\ldots\ldots (35)$$

where

d_o = the initial jet diameter.

Equation 35 is in substantial agreement with the results of Tuve and Priester[14] and thereby lends support to their more extensive data.

Equations 34 and 35 are both limited to isothermal conditions.

The non-isothermal jet is very inadequately understood[16], despite its great practical importance. The nature of the unsolved problems will be indicated here by presenting the data of Schmidt[17]. Fig. 7 shows his cross-stream temperature and velocity traverses for a cylindrical jet at various distances from the origin. The evident dissimilarity between the two profiles complicates any analysis, and yet both temperature and velocity are of air-conditioning importance.

The analysis of a heated cylindrical air jet rising vertically as developed by Schmidt further showed the centerline velocity to vary as $x^{-1/2}$ and the centerline temperature as $x^{-5/3}$, where x is the distance along the jet measured from an equivalent point source. The equivalent point source for a finite outlet may be established by experiment or approximately located upstream from the outlet plane at the position of the vertex of the jet expansion angle. Much further study is needed on all of these matters.

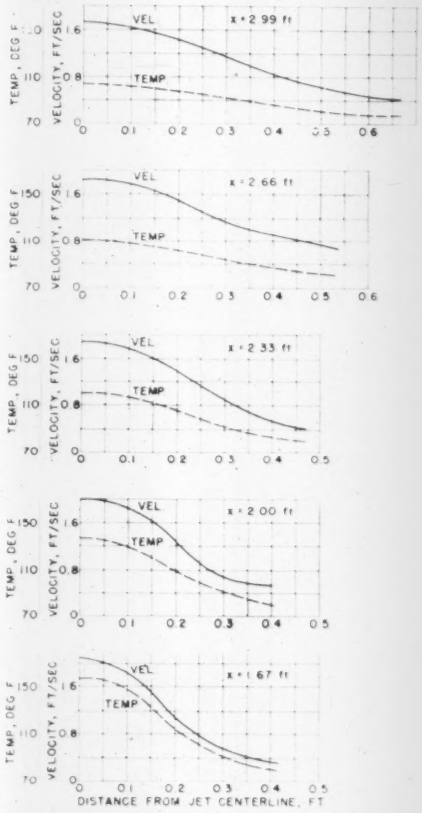

Fig. 7—Experimental velocity and temperature profiles for a heated cylindrical air jet (taken from Schmidt[17])

x = distance referred to equivalent point source of jet. Surrounding air at rest with temperature of 71.1 F. Jet rising vertically

Conclusions

1. The true, microscopic, fundamental mechanisms of turbulence are at present incompletely understood.

2. Carefully-conceived engineering empiricisms offer the best means for obtaining workable solutions to turbulence problems of practical importance. Such empiricisms must be guided by the best analytical work attainable, the total of past experience, and the results of very careful experimentation.

3. Much additional experimental research is needed on engineering problems of turbulent flow and air distribution, and improved instrumentation in this connection is a prime requirement.

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12. Eddy Diffusion, by W. L. Towle and T. K. Sherwood. (*Industrial and Engineering Chemistry*, Vol. 31, 1939 p. 457.)

13. Calculation of Turbulent Expansion Processes, by W. Tollmien. (*Zeitschrift fur angewandte Mathematik und Mechanik*, Vol. 6, 1926, p. 1. Translation in *NACA Technical Memorandum No. 1085*.)

14. ASHVE Research Report No. 1248—Control of Air Streams in Large Spaces, by G. L. Tuve and G. B. Priester. (ASHVE Transactions, Vol. 50, 1944 pp. 153-172.)

15. Diffusion of Submerged Jets, by M. L. Albertson, Y. B. Dai, R. A. Jensen and Hunter Rouse. (Iowa Institute of Hydraulic Research, State University of Iowa, June 30, 1947. To be published in *ASCE Transactions*.)

16. Isothermal and Non-isothermal Air-Jet Investigations, by V. Cleeves and L. M. K. Boelter. (*Chemical Engineering Progress*, Vol. 43, March, 1947 p. 123.)

17. Turbulente Ausbreitung eines Stromes erhitzter Luft, by W. Schmidt. (*Zeitschrift fur angewandte Mathematik und Mechanik*, Vol. 21, 1941 pp. 265-278 and 351-363.)

Nomenclature

a_o = pipe radius, feet.
b_o = slot width for Equation 34, feet.
C = concentration, pounds per cubic foot.

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c_p = unit heat capacity at constant pressure, Btu per (pound) (Fahrenheit degree).
d = differential operator, dimensionless.
d_o = initial jet diameter for Equation 35, feet.
D = eddy diffusivity, square feet per second.
f = friction factor, dimensionless.
K_1 = empirical constant in Equation 25, dimensionless.
k' = thermal conductivity, Btu per (hour) (square foot) per (Fahrenheit degree per foot).
L = $\sqrt{x^2 + y^2}$, feet.
l = mixing length, feet.
l_s = scale of turbulence, Equation 7, feet.
m/A = diffusion mass transfer, pounds per (hour) (square foot).
N_{Re} = Reynolds Number for pipe flow, dimensionless.
P = mean static pressure, pounds per square foot.
p = fluctuating component of static pressure, pounds per square foot.
q/A = heat transfer, Btu per (hour) (square foot).
R = correlation defined by Equation 5, dimensionless.
R_s = correlation defined by Equation 6, dimensionless.
s = time interval, seconds.
T = mean temperature, Fahrenheit degrees.
t = fluctuating component of temperature, Fahrenheit degrees.
U = x-component of mean velocity, feet per second.
u = x-component of fluctuating velocity, feet per second.
V = y-component of mean velocity, feet per second.
v = y-component of fluctuating velocity, feet per second.
U_c = mean velocity on pipe axis, feet per second.
U_{mean} = mean velocity through pipe, feet per second or feet per minute.
U_o = initial mean velocity of jet, feet per second.
U^* = $\sqrt{\tau_o/\rho}$, feet per second.
U_s = $\sqrt{\tau/\rho}$, feet per second.
w = source strength, dust particles by weight per second.
x = coordinate dimension, feet.
y = coordinate dimension, feet.
β = eddy conductivity, Btu per (hour) (square foot) (Fahrenheit degree per foot).
ε = eddy viscosity, square feet per second.
ν = kinematic viscosity, square feet per second.
μ = absolute viscosity, (pound) (second) per square foot.
ρ = mass density, (pound) (second)^2 per (foot)^4.
τ = shear stress, pounds per square foot.
τ_o = shear stress at pipe wall, pounds per square foot.
τ_v = shear stress from viscous action, pounds per square foot.
τ_t = shear stress from turbulent action, pounds per square foot.

A bar over a symbol or product denotes a mean value thereof.

Discussion

MR. TASKER commented that Mr. Nottage's paper was attempting to find the *why* in the study of ventilation jets, and that further experimental work of this type was needed.

M. K. FAHNESTOCK, Urbana, Ill., remarked that the conduct of fundamental research was a Society responsibility according to the Constitution, and that the present paper indicated a proper trend in this type of basic research. He also suggested that a Technical Advisory Committee be formed and that the members of this Committee should be especially competent to discuss the fundamental equations presented by Mr. Nottage. He said that such a Committee should be able to understand the combination of Greek symbols and translated German words used in the nomenclature of aerodynamics and fluid mechanics, and should be able to develop a terminology more suitable to the use of the heating and ventilating engineer.

W. O. HUEBNER, New York, N. Y., complimented Mr. Nottage on the type of work done in the paper.

J. J. AEBERLY, Chicago, pointed out the need for more exact language, in terms of the physical laws of the conservation of energy and the conservation of momentum.

NEW INTERNATIONAL TEMPERATURE SCALE

A revised scale for increased precision in measuring temperature was being used in the United States on January 1, 1949. The new scale had been adopted in October 1948 in Paris by the Ninth General Conference on Weights and Measures, and is the first revision of the International Temperature Scale in 21 years.

The International Temperature Scale was first established in 1927 for the purpose of eliminating difficulties in measuring temperatures on the thermodynamic scale (an ideal scale based on energy changes in a Carnot cycle). The I.T.S. is based on 6 fixed points: the boiling point of oxygen; the freezing and boiling points of water; the boiling point of sulfur; the melting point of silver; and the melting point of gold. The temperatures range from — 182.97 C (boiling point of oxygen) to + 1063 C (melting point of gold).

In the new scale, all temperatures above the gold point (1063 C) are changed, by reason of the adoption of a new value for the constant C_2 in the radiation formulas. The use of Planck's instead of Wein's law is now specified, removing the upper limit to the scale which was imposed by the use of Wein's law.

Other modifications in the scale include the specification of platinum of higher purity for the standard resistance thermometer and standard thermocouple.

ENGINEERING INSTITUTE TO BE HELD IN JUNE

An institute on Heat Transfer and Fluid Mechanics will be held June 22-24 on the Berkeley campus of the University of California.

Technical sessions will be held on the general fields of heat transfer and of fluid mechanics, and on energy conversions, combustion, instruments, multiphase flow, and drop dynamics.

Among the sponsoring societies are: the *American Institute of Chemical Engineers, American Society of Mechanical Engineers, American Society of Refrigerating Engineers, American Institute of Mining and Metallurgical Engineers, American Chemical Society, American Mathematics Society*, and the *American Physics Society*.

The sponsoring universities include Stanford, Southern California, Santa Clara, California at Los Angeles and Berkeley, and the California Institute of Technology. Information and accommodations can be obtained from the Department of Institutes, University of California, Berkeley 4, Calif.

Discussions at 55th Annual Meeting

Physiologic Adjustments

THE paper, **Physiologic Adjustments of Normal Subjects and Cardiac Patients to Sudden Change in Environment**, by Nathaniel Glickman, Tohru Inouye, R. W. Keeton, M.D., I. R. Callen, M.D., F. K. Hick, M.D., and M. K. Fahnestock, was presented by Professor Glickman.

CAPT. A. R. BEHNKE, Bethesda, Md., suggested in a written discussion that the title mention the difference in ages between normal subjects and cardiac patients. The pulse rate changes were of interest and these must be interpreted in connection with alteration of blood pressure, it was suggested.

R. W. KEETON, M.D., Chicago, felt that a title change as suggested by Captain Behnke was not indicated. If age effect is considered, then subjects should be in normal state of health for their respective ages in order to make valid comparisons. In the study under discussion, Dr. Keeton maintained, the cardiacs could not be classed as old subjects.

C. S. LEOPOLD, Philadelphia, stated that this paper put the scientific stamp on the daily observation that no ill effects were felt on transition from cold interior to hot outdoors.

CYRIL TASKER, ASHVE director of research, Cleveland, pointed out that the studies which included the paper under discussion were being conducted by the Technical Advisory Committee on Physiological Research, with Dr. C.-E. A. Winslow as chairman. Mr. Tasker also pointed out that the Association of American Railroads and the U. S. Public Health Service were giving support to the Society's Physiological Research project.

LESTER T. AVERY, Cleveland, discussed the past work of the Society regarding the limits of cold and heat which the human body can stand. The next step, said Mr. Avery, is to determine the optimum condition which can be safely recommended for living and working, not only from the standpoint of comfort but also from the standpoint of health.

M. K. FAHNESTOCK, University of Illinois, cautioned members not to think of the paper as the entire answer to the movement of healthy and of impaired individuals from one environment to another. Radiation effects would create an entirely different situation, and in various industries or the armed services, changes in environment might impair or affect even normal persons, Professor Fahnestock said. He requested that the type of subject, the cardiac patient, be kept in mind before a conclusion is made.

MR. LEOPOLD replied to Prof. Fahnestock's remarks that the comments made in the discussion were directed to ordinary operations and that severe climatic changes might impair a person's functions.

H. E. ZIEL, Detroit, asked whether those with high blood sugars might be affected adversely, more so than the cardiac patient, and what method might be used for measuring this effect.

AUTHOR'S CLOSURE: Thanking all for their comments, Prof. Glickman pointed out that the tabular data of the paper gave the type of heart condition. Additional work is being done, he said, regarding normal activities and it was found that a small group of individuals are heat susceptible. But regarding larger temperature gradients and radiation effects, Prof. Glickman said that these effects could not be included in the present studies.

Solar Heat Transmission

Overall Coefficients for Flat Glass, Determined Under Natural Weather Conditions, by G. V. Parmelee and W. W. Aubele, was read at the Monday technical session.

C. M. ASHLEY, Syracuse, N. Y., urged the correction of values for double glass and pointed out that inside wall temperature should not be assumed to be the same as glass temperature. A lower temperature difference exists between the other surfaces and the air than exists between glass surfaces, and the single glass factor is therefore too high, Mr. Ashley stated.

MR. TASKER described the part of the present paper in the 3½-year research program of the ASHVE Laboratory, and mentioned that Bulletin No. 1 by Mr. Parmelee on the subject of heat transmission through glass was now available to members.

R. A. MILLER, Pittsburgh, outlined the work of the Technical Advisory Committee on Glass and invited the cooperation of ASHVE members.

MR. PARMELEE, giving the author's closure, said that in regard to the overall coefficient concept, this idea had been abandoned with reference to heat flow through sunlit walls and roofs.

Replying to Mr. Ashley, Mr. Parmelee stated that it was hoped that THE GUIDE information for heat loss through glass would be improved. Hot box tests have shown that in all-glass construction the overall coefficient is materially reduced with the absence of radiation effects. This information is in Bulletin No. 1, Mr. Parmelee said.

Cooling Tower Performance

N. W. Snyder, the author, presented his paper, **The Internal Performance of an Induced Draft, Packed Cooling Tower**, at the Tuesday technical session.

H. E. DEGLER, Kansas City, Mo., read his written discussion of the paper. He said that the tower under discussion did not simulate actual design because of its dimensions. It would be interesting, Mr. Degler noted, to know the effect of streamlined egg-crate (channeled and stratified) air stream flow as and immediately after the air enters the bottom of the tower. He further noted that this experimental water-cooling tower could be quite adaptable for a subsequent investigation of the effect of changing the wet-bulb temperature of the air entering the tower. He concluded by saying that this is basic research of value to all persons interested in the cooling of water with air.

F. EDWARD INCE, St. Louis, made the distinction between performance of the

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tower under discussion and the performance of a commercial tower. He said that the surface performance through the extreme height of the subject tower was not what was expected of a commercial unit. The performance shown by the spray nozzle indicated that the packing is of little consequence, Mr. Ince said, and perhaps a series of nozzles would be better than having any paeking at all.

In giving the closure, PROF. SNYDER remarked that the present paper has answered some of the points concerning the better arrangement of sprays in the tower. He said the tower did not simulate commercial towers because no commercial construction was available. He also told the audience that he had charted the effect of having a series of sprays, as Mr. Ince pointed out, through the tower vertically, and he had indicated there would be no difference in having one single spray.

Refrigerant Heat Transfer Rates

The second paper at Tuesday's technical session was **Heat Transfer Rates for Refrigerant Boiling in Horizontal Tube Evaporators**, by L. G. Seigel, W. L. Bryan and M. C. Huppert, and was read by Prof. Seigel.

H. B. NOTTAGE, Cleveland, presenting a written discussion, said that if the paper is to be published in the TRANSACTIONS, complete data should be added for each run. Such data should include: (1) the initial and final state of the refrigerant; (2) refrigerant flow rate; (3) heat transfer rate; and (4) tube inner surface temperature distribution. More details on the heat loss calibration would be of interest, Mr. Nottage said, and the use of electrical tube heating would mean a uniform heat load per unit of tube length except for variations in loss to the surroundings, longitudinal conduction, and the distortion at the bend.

MR. ASHLEY called the paper significant since it increased knowledge in an area hitherto neglected. He compared the results of the present paper with his own test data of 1941, based upon tests of a single tube length and largely at saturated leaving conditions. He said that the validity of the present series of tests must be considered as limited to low loading, but that they could be used conservatively for higher loading. He asked that the essential original test data be included in the final draft of this heat transfer paper.

Inquiring about Fig. 3, MR. INCE wished to know whether the ordinate, Δ T, included superheat or whether it was saturated refrigerant temperature.

W. L. BRYAN gave the closure, and said that any data requested would be sent to interested parties. Agreeing with Mr. Nottage's discussion, he noted, however, that Fig. 3 was an illustration rather than a presentation of data. He summarized results with the tube size used, and said that increase of the tube length was necessary to explore what takes place beyond the 9000 Btu per hour load. Answering Mr. Ince's question, Mr. Bryan said that 15.3 was the maximum temperature difference.

Air Conditioning Estimate

C. M. ASHLEY, the author, presented his paper, **Psychrometric Factors in the Air Conditioning Estimate.**

MR. AVERY, in discussing Mr. Ashley's paper, emphasized that errors are still made regarding outside air to be brought in through the apparatus. He called the cleaning of the coil an important problem, with increase in coil depth adding to the difficulty of cleaning. He has found the old design of 80 deg and 50 percent relative humidity or 74 deg ET too high, and said that systems are now designed for 71 deg ET.

P. R. ACHENBACH, Washington, D. C., asked two questions: 1. Is the bypass factor of the specific coil a function of the coil only or is it also a function of the sensible heat appearing in the room? 2. Regarding Fig. 7, does this method provide a means for pre-selecting the difference between the supply air temperature and the room dry bulb desired?

L. G. SEIGEL raised the point that the method of solution proposed seemed to depend primarily on the knowledge of the apparatus dew point, which depends on the intersection of the load ratio line with the saturation curve. Therefore, Prof. Seigel inquired, could the intersection in other problems be solved by the method proposed in the paper?

MR. INCE referred to Fig. 4 of the paper, which showed the coil performance line as being a curved line intersecting the room performance line. However, Mr. Ince pointed out, the extreme bending of this line is a function of refrigerant temperature as well as of the loading of the coil. Since the intersection point would be a function of the bypass, Mr. Ince felt that the bypass would be difficult to single out, but that it should be recognized if it actually occurred.

Giving the closure, MR. ASHLEY said that the bending of the condition line was exaggerated for the purpose of illustration. Actually, the condition line was bent far less than shown. He added that the bypass of the coil was a function completely and entirely of the coil, and had nothing to do with the room conditions or the sensible heat factor. He urged additional improvement on current methods of heat estimating.

Automatic Air Shutters

Are Automatic Air Shutters Justified on a Gas-Fired Conversion Burner? by W. M. Myler, Jr. and H. W. Nelson, was presented by Mr. Myler at the Wednesday morning technical session on domestic heating.

CARL H. FLINK, New York, N. Y., pointed out that since draft hoods are invariably used with gas appliances and since these draft hoods have fixed openings which permit escape of warm air from, as well as entrance of cold air into, the flues when the gas is turned off, an air shutter at the appliance inlet cannot actually prevent escape of heat.

R. K. THULMAN, Washington, D. C., asked if the effectiveness of the air shutter might not be increased in the case of a boiler other than the wet base type. He also inquired what effect might result under different kinds of temperature, particularly regarding the mass involved in the temperatures.

W. J. WATCHLER, Cleveland, Ohio, asked why the wet-base boiler and an inshot burner were chosen for the investigation discussed in the paper.

In his closing remarks, MR. MYLER said he did not cover the subject of Mr. Flink's discussion in his paper, although he was aware of its effect. In the design of the subject air shutter, he pointed out, absolute air closure was not feasible because the pilot light needed a small amount of air.

The choice of a wet-base boiler was made, he said, because this type seemed to lend itself most readily to the determination of the types of results desired. Thus, steam boilers would have been more difficult to operate on an intermittent basis. He emphasized that the intention was to study differences of efficiency, with selection of a particular boiler incidental.

Study of 14 Chimneys

The next paper presented was **Performance of Fourteen Masonry Chimneys Under Steady State Conditions,** by P. R. Achenbach and S. D. Cole, and was presented by Mr. Achenbach.

MR. THULMAN gave a written discussion of the paper. He stated that the wording of the paper's conclusion No. 3 gave the impression that the 7 in. round flue was not equivalent in capacity to the 7 in. square flue. He suggested a revision of this conclusion to give equivalence between the two types of flues up to 70 cfm flow rate and 550 deg F inlet temperature. Even at this unusually high flow rate and high inlet temperature, Mr. Thulman said, the performance of the 7 in. round in terms of observed draft was only 12 percent less than that available in the large 7 in. square flue.

Another written discussion was read by VAUGHN H. HILL, Lansing, Mich. Mr. Hill compared the present paper with a previous one by Dill, Achenbach and Duck, published in 1942, and said that the present paper shows considerably higher drafts than those described in the previous paper.

H. M. NOBIS, Cleveland, Ohio, said that he should prefer a chimney entrance at an angle of 45 deg instead of at a 90 deg angle. This would create less friction and provide more benefit, he said.

W. A. DANIELSON, Memphis, Tenn., stated that the advantage of the metal liner was for a modern plant with intermittent heating, and asked for data to clear up this point.

D. H. WYATT, Columbus, Ohio, requested information on the use of transite flues for high temperatures.

BERT P. FISHER, Houston, Tex., pointed out that in gas-burning equipment, aluminum liners were used, and he compared various types of flues regarding condensation of flue products and creation of draft.

MR. THULMAN said that the present paper was only a part of a comprehensive chimney research program, dealing with three temperature ranges: those encountered in domestic heating appliances; extremely low temperatures; and temperatures in excess of 1000 deg and also ranging from 800 to 1800 deg.

MR. ACHENBACH, giving the closure, said that conclusion No. 3 should be somewhat more elaborate, and that smoke pipes entering at an angle of 45 deg would believably reduce the friction and provide a better streamlined flow of the gases in the chimney than the 90 deg entrance. Mr. Achenbach also spoke of various types of liners, particularly with reference to fire hazard, which increased with high temperatures of 1400 or over.

Residential Chimneys

Performance of Residential Chimneys, by L. B. Schmitt and R. B. Engdahl, was presented by Mr. Schmitt.

MR. ACHENBACH gave a written discussion comparing results of the present paper with those obtained at the National Bureau of Standards, with general agreement. He said, however, that the data presented on pickup are too meager to warrant the conclusions drawn. He also pointed out that Fig. 14 was doubted as giving results within ±10 percent for heights up to 30 ft because of the greater cooling of the gases in taller chimneys.

MR. FLINK questioned Mr. Achenbach's statement regarding the amount of air to be used with a gas appliance. He stated that adjustment of a gas appliance was more nearly to 35 percent excess air rather than 20 percent as suggested.

MR. ACHENBACH stated that according to THE GUIDE the average excess air was likely to be 35 percent for gas burners but it could be as low as 20 percent.

MR. PARMELEE requested that more information be added in the paper regarding friction losses, since the present study offered more opportunity to obtain good friction data on non-isothermal flow.

J. H. CLARKE, Chicago, discussed the ram effect or positive pressure relative to the ventilator heads. In his own (marine) experience, Mr. Clarke said, no back draft was obtained on ventilators except where the internal part of the vessel was subjected to a negative pressure. He asked for explanation of the data of the paper to account for the positive pressure.

MR. ENGDAHL, presenting the closure, pointed out the agreement between the present paper and that read earlier in the session. He explained that variations in excess air would result from use of different fuels. But on the basis of automatic heat, he said, the differences are much smaller than were cited in the discussions. Regarding pickup rate, he stated that the difference was small, regardless of chimney construction, according to the results of the paper.

MR. ENGDAHL agreed with Mr. Parmelee on the matter of friction losses, and said that one friction was obtainable for isothermal conditions but another for non-isothermal conditions. In the paper, he said, the assumption was made that the two were the same for all practical purposes. In the matter of positive pressure, Mr. Engdahl said that under the conditions tested, perhaps a condition not encountered in marine experience resulted, which showed that a positive pressure could be obtained under certain wind orientation.

Insulation and Panel Heating

Performance of an Electrical System of Panel Heating With Four Stages of Insulation, by R. J. Lorenzi and J. F. Schreiber, was presented by Mr. Lorenzi.

Presiding officer G. L. Tuve read a written discussion by HOWARD C. MURPHY of California. Mr. Murphy wrote regarding local installations of electrical panel heating. In these installations, he pointed out that adequate insulation was of major importance, and that panel heating profited by proper insulation, adequate controls and good engineering.

PROFESSOR TUVE pointed out that many changes were taking place in the world's energy supply. The question of energy sources would become increasingly predominant in coming years, he said, and particularly as applied to heating, ventilating and air conditioning systems. Whether the energy came from one of the usual types of fuel or whether it would come from the heat pump source, or from an atomic pile—such questions would be important in the future. In the production of comfort, economics as well as technology must be considered, he said, and alluded to the paper under discussion as one that illustrated this point.

E. P. PALMATIER, Syracuse, N. Y., asked for clarification of the tabular data as to the heat factor that was included in the calculation.

R. A. MILLER asked for an explana-

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tion of the terms, *double glazing* and *storm sash.*

MARTIN CHRISTESEN, Englewood, N. J., wished to know if any records were made of the differences in temperature between the ceiling and the floor during operation of the panel.

C. H. RANDOLPH, Milwaukee, requested information on whether fuel costs in an electrical panel heating system would be figured on any basis other than that used with a standard conventional type.

A. S. CHIPLEY, Libertyville, Ill., asked if the control was constant or whether it was switched on and off.

MR. TASKER suggested that on the basis of the figures given in the paper no step beyond Step 2 or the first step of insulation was significant, since some slight change in the net installation investment might easily wipe out the small differences existing between steps 2, 3 and 4.

R. E. REEVES, Chattanooga, Tenn., mentioned installations in his locality and spoke of the comfort of homes having radiant heat and those having straight resistance heat.

PROFESSOR FAHNESTOCK wished to know if the authors of the paper had any objective measurement of comfort in the study undertaken.

R. L. REILLEY, Texarkana, Ark., asked for information on the material used in the panel.

MR. LORENZI'S closing remarks included explanation of the heat factor. The volume used, he said, was the entire volume of the occupied area including the partition volume. Storm sash and not double glazing was used in the study of the house. Regarding temperature gradient, Mr. Loren[illegible] replied that in general the floor to ceiling grade was of the order of 10 to 12 deg as measured from a point [illegible] in. above the floor to a point 6 in. below the ceiling.

The controls used were of the on-off type, with a thermostat in each of the four major rooms and also one in the bathroom, Mr. Lorenzi explained. Fuel costs for electrical heating were based on the present day concept of predicting such costs. In reply to Mr. Tasker's suggestion, Mr. Lorenzi stated that comfort conditions were much improved by adding extra insulation. With reference to comfort, he replied that no attempt was made to obtain elaborate information on this subject from the occupants or to measure it by having results from them.

Radiant Baseboard for a Basementless House

R. H. Weigel presented the paper, **Heating a Basementless House With Radiant Baseboard**, by W. S. Harris and Mr. Weigel.

G. S. MACLEOD, Chicago, asked whether the radiant heat boards in the bathroom and kitchen were both completely exposed. He also asked for a determination of the relative values of the radiant and convected heat transfer.

E. R. TESKE, Chicago, suggested that the elimination of smudging with the RC type or with radiant baseboard, as mentioned in the presentation, was not backed by test data. He used a practical example as illustration, and concluded that water temperature was not the major influence.

MR. WEIGEL, giving the closure, stated that the radiant baseboard in the bathroom was uncovered, but that in the kitchen a stove was located in one corner. Determination of the relative values of heat transfer by convection and radiation from the units was not undertaken in the tests, Mr. Weigel said. Regarding smudging, he said that dirt patterns would be eliminated if the design water temperature were lower than 200 deg. He pointed out, however, that a slight change in the design, particularly of the convector units, would help to eliminate the dirt pattern.

Panel Time Response

The paper, **Heating Panel Time Response Study**, by A. B. Algren and Ben Ciscel, was presented by Mr. Ciscel.

MR. MACLEOD asked whether any correlation was determined between the method of thermocouples taped to each wall and the use of the eupatheoscope or the globe thermometer.

E. A. JONES, Dayton, Ohio, discussed the conclusions of the paper, with particular reference to the drop in temperature in controlling the addition of heat in the house or a reversal of the temperature trend outside. He suggested securing good control by leaving off storm sash and insulation.

MR. CHIPLEY spoke regarding a system of pipes suspended from the ceiling, with panels attached to the pipes and control established by a room thermostat. He used this illustration to ask what was being measured and how the chart showed the extent of comfort.

In his closing remarks, Mr. Ciscel said that no correlation was attempted between the wall surface thermometers used in the study and the instruments suggested in the discussion.

A cooling run was made at one time, Mr. Ciscel said, to see how much heat could be got back out of the panel system. Regarding the measurement problem, he emphasized that the panel alone was the subject of investigation in the paper, and that comfort was not considered a part of the investigation.

Air Distribution and Draft

In the absence of the authors, John Rydberg and Per Norbäck, C. M. Humphreys read their paper, **Air Distribution and Draft.**

MR. HUMPHREYS, after reading the paper, presented his own written discussion. The authors, he stated, limit the application of their equations to jets which are not disturbed by surrounding walls and in which no guide vanes are employed. Normal and uniform approach to the outlet must also be a prerequisite. Such limitations would preclude the use of the proposed method in the actual design of air conditioning systems, Mr. Humphreys said.

MR. NOTTAGE commented on the oversimplification of complicated problems in air distribution, and pointed out that certain information regarding the Reynolds number and effective temperature as used in the United States was lacking. But the authors, Mr. Nottage said, deserve encouragement for their work in attempting a quantitative definition of draft.

A written discussion by ALFRED KOESTEL and PHILIP HERMANN described research conducted at Case Institute of Technology on air flow performance from perforated panels. It was pointed out that the theory and physical behavior of air jets leaving a grid, as described in the present paper, were similar to the findings of the research conducted at Case.

A BIT OF TEXAS CAME TO CHICAGO

By J. P. Ashcraft

A contingent of enthusiastic Texans came to Chicago to say "Howdy" to their fellow members at the 55th Annual Meeting and repeat their invitation, "Come see us in 1950." Led by C. Rollins Gardner, general chairman of the Committee on Arrangements for the 1950 Annual Meeting, a nine-car Santa Fe Special with 127 aboard arrived in Dearborn Station on January 23, with representatives from the three Texas Chapters and others picked up en route at Oklahoma City and Kansas City.

There was fun and excitement for everyone on this Texas Special, and one of the highlights of the trip was the suggestion and preparation of a petition to charter a special mobile chapter. Elected by acclamation were: President—Reg F. Taylor, First Vice President—C. Rollins Gardner, Second Vice President—C. C. Quin, Third Vice President—Ira Wilkie, Fourth Vice President—Wally Frankfurt, Fifth Vice President—George H. Jackson, Recording Secretary—Robert J. Salinger, Secretary—George A. Linskie, Treasurer—Phil Ashcraft, Sergeant-at-Arms—H. G. Clark, Assistant Sergeant-at-Arms—C. P. Howard, and Assistant Assistant Sergeant-at-Arms—Karl Martino.

The petition to Council was signed by the required number of members in good standing and presented to Council by Mr. Gardner as his first official act as a member of that body. (The Council received the "petition" and acted immediately to place it on file among its historical records.)

The 25th floor of the Stevens was set up as Texas Headquarters and caucuses could be found going on at any time of the day or night. The special Texas badges were prominently displayed throughout the meeting and the Exposition, and the Texans were encountered everywhere, day and night, collecting ideas for 1950.

At the Annual Banquet, Mr. Gardner presented the invitation to members to come to Dallas in 1950 for the Annual Meeting.

A pleasant interlude in the busy week occurred on Thursday when a committee, headed by General Chairman Gardner, appeared at Chicago's City Hall to present a ten-gallon hat to Mayor Kennelly and invite him to head the Chicago delegation to Texas in 1950. It was keenly regretted that our *Four Horsemen* could not ride their ponies up City Hall steps to call on the Mayor.

The Texas group found the Chicago Meeting a stirring challenge for 1950 and look forward to seeing a big crowd of their friends next January.

A happy group en route to Chicago—Seated in foreground, R. J. Salinger, secretary, South Texas Chapter, and G. A. Linskie, president, North Texas Chapter

C. Rollins Gardner, T. H. Anspacher, and Reg F. Taylor, Past Presidents of North Texas Chapter on "Texas Special"

The Four Horsemen of North Texas Chapter—C. Rollins Gardner, E. T. Gessell, J. A. Ray and G. A. Linskie, with their wives arrive back in Texas to find an all-time low of −2 deg

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AN INVITATION TO ASHVE MEMBERS

On behalf of the Minneapolis Chapter—and my personal wishes are implicit in this expression—I want to extend a cordial invitation to every member to attend the ASHVE Semi-Annual Meeting in Minneapolis, June 19-22, 1949.

The Committee is working very hard and having a lot of fun planning an extremely interesting and unusual program which will fill the days—and nights—of the meeting with activities calculated to provide instruction and entertainment for everyone.

Minnesota, recently titled *The Theater of Seasons*, is celebrating its Centennial this year, and every visitor will share in the festive *Anniversary Atmosphere* which prevails. Our justly famous resort and vacation facilities are more than ample to provide recreation and rest for weary engineers, rambling wrecks and all lovers of the outdoors.

I would like to suggest that Society members plan their annual vacations to coincide with the Meeting. The Minneapolis Tourist Information Bureau has offered to furnish complete information on resort and vacation areas to all members who are interested. A postal card to its offices at Hennepin and Washington Ave. South, here in Minneapolis, will bring full information.

The Committee joins with me in extending a personal invitation to every member. After we have pulled through one of our Arctic Winters, we like to combine business with pleasure during our beautiful Summer Season. We want every member and his family to come up for a wonderful time!

Very truly yours,

John E. Haines, *General Chairman*
Committee on Arrangements

April 1, 1949.

WELCOME TO MINNESOTA

June 19-22, 1949

MINNESOTA is delightful in June and the members of the Society will gather in Minneapolis during the period June 19-22 for the Semi-Annual Meeting 1949.

The Minnesota Chapter, composed of members from the Twin Cities, has announced the appoint-

Aerial view of Minneapolis

ment of a Committee on Arrangements with John E. Haines, *General Chairman;* Lyman C. Gross, *Vice Chairman;* Prof. F. B. Rowley, *Honorary Chairman;* David B. Anderson, *Banquet;* James S. Locke, *Entertainment;* Chester T. Lawrence, *Finance;* Hiram K. Johnson, *Ladies;* Axel B. Algren, *Reception;* Bruce F. McLouth, *Sports;* G. Mitchell Kendrick, *Transportation;* and Hartzell C. Mills, *Publicity.*

The general chairman of the Committee on Arrangements, John E. Haines, has issued the accompanying invitation to all ASHVE members.

The Nicollet Hotel will be headquarters for the various activities which will open on Sunday, June 19, with a series of committee meetings and on the following three days technical sessions will be held, as well as golf and other outdoor sports and a program that will be especially attractive to the ladies.

Minneapolis is situated at the head of the navigable Mississippi River which winds through the downtown section and the city is dotted by dozens of lakes and contains many points of interest. The city is served by several major railroad lines en route to the Pacific coast and through its airport there is service to all points of the compass by several of the larger airlines, including Northwest, Mid-Continent, Capitol, Western, and Wisconsin-Central.

Hotel Nicollet—Semi-Annual Meeting Headquarters

Preparations are under way for special train service between Chicago and Minneapolis on June 19 and railroad rates from Chapter cities are presented.

The Committee on Arrangements of Minnesota Chapter has suggested combining business with pleasure and calls attention to the availability of many famous resort and vacation facilities which are available. In planning itineraries, consideration might be given to the Minnesota lake district, the scenic areas of the Black Hills, Yellowstone Park, the Canadian Rockies, and Pacific coast areas.

The Program Committee of the Society has indicated that some of the subjects for discussion at the technical sessions will include physiological limits for extreme heat, solar heat transfer, a session on the heat pump, air distribution, radiant heat, and hospital heating and air conditioning.

There will be meetings of the Council, Committee on Research, Nominating Committee, Chapter Delegates and many Technical Advisory Committees.

The Minnesota Chapter members look forward to greeting Society members in June.

RAILROAD & PULLMAN FARES TO MINNEAPOLIS

From	Round Trip Rail*	One Way Pullman*	From	Round Trip Rail*	One Way Pullman*
Atlanta	$ 69.40	$ 9.25	New Haven	94.97	10.65
Boston	99.09	10.65	New Orleans	78.60	10.95
Buffalo	62.95	7.75	New York	89.15	10.65
Chicago	23.75	3.50	Norfolk	85.00	10.65
Cincinnati	46.70	5.70	Oklahoma City	48.55	8.35
Cleveland	50.10	6.60	Omaha	20.55	3.50
Columbus	48.15	6.60	Philadelphia	82.70	10.05
Dallas	57.45	10.05	Pittsburgh	59.15	7.20
Denver	51.75	8.65	Portland	95.70	15.75
Des Moines	15.55	3.50	Raleigh	96.30	12.40
Detroit	45.95	5.70	St. Louis	34.10	5.05
Grand Rapids	38.57	7.00	Salt Lake City	78.60	12.60
Houston	71.00	12.00	San Antonio	82.25	12.00
Indianapolis	38.57	5.70	San Francisco	114.25	18.25
Kansas City	28.60	5.05	Seattle	95.70	15.75
Los Angeles	114.25	18.25	Shreveport	40.80	11.80
Manitoba	25.05	4.10	Syracuse	72.65	8.65
Memphis	55.55	7.75	Toronto	60.15	5.70
Milwaukee	15.05	3.50	Tulsa	43.00	8.55
Montreal	80.85	9.25	Washington, D. C.	78.95	10.05

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Summary of Local Chapter Meetings*

Central New York—February 16, 1949. The meeting was called to order at 8:00 p.m., by Pres. D. L. Mills following dinner at Howard Johnson's Restaurant.

President Mills reported briefly on the 55th Annual Meeting in Chicago. Chapter delegate V. S. Day, was unable to attend the meeting and will make a full report on the Annual Meeting at the next meeting.

Treas. A. L. Jones made his monthly report and L. E. LaRow, program chairman, announced that the next meeting would be held at Ithaca, N. Y. on Wednesday, March 16.

H. A. Lockhart, chief engineer of the Bell & Gossett Co., Morton Grove, Ill., spoke on *Hot Water Piping Systems* and their comparative merits. He also contributed several suggestions on the design and operation of hot water heater systems. Mr. Lockhart's talk and blackboard illustrations provoked a lively discussion period. Attendance 63. Attendance ratio 0.35.

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Central Ohio—January 17, 1949. A talk on the *Silicosis Problem in Ohio* was the feature of the meeting held at the Chittenden Hotel, Columbus, and the speaker was L. M. Merritt of the Division of Safety and Hygiene, Industrial Commission of Ohio. Mr. Merritt also gave a report on Pearl Harbor, December 7, 1941, where he was at the time.

N. T. Hess announced *Indoor Comfort Conferences* would be held in April under the sponsorship of the *National Warm Air Heating and Air Conditioning Association*. Attendance 23.

Connecticut—January 21, 1949. At the meeting in the University Club, Hartford, Pres. E. C. Marsden appointed R. L. Maher Chapter representative of the ASHVE Research Committee. P. J. Lamoureux was appointed temporary alternate for the Annual Meeting.

D. M. Hummel described the bill now before the Connecticut Legislature to be known as the Engineer's Registration Bill. J. F. Stone, Johns-Manville, New York, N. Y., gave an interesting talk on *Insulation*. Attendance 44. Attendance ratio 0.19.

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Delta—January 15, 1949. A Joint Meeting of Delta Chapter and the New Orleans section of *ASRE* was held at the St. Charles Hotel. Presiding were L. V. Busenlener, president of Delta Chapter, and Cal Crawford, vice-chairman of the New Orleans Section of the *ASRE*.

Mr. Busenlener extended a cordial welcome to the guests and J. S. Burke introduced the speaker, Bruce A. Jacobi, New York, N. Y., chief engineer of Lerner Stores Corp. Mr. Jacobi gave an informative talk, entitled *Chain Store Air Conditioning*. At the conclusion of his talk, Mr. Jacobi answered a number of questions from the floor. Attendance 75.

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Delta—January 13, 1949. Delta Chapter held its January meeting in two sessions, both in conjunction with the Annual Meeting of the *Louisiana Engineering Society*.

In connection with the January 15 session, Pres. L. V. Busenlener pointed out that about 150 guests had been invited.

Members were urged to cooperate with and assist Elmer May, chairman of the Chapter's research committee regarding the Society's request for comment on the research program.

J. S. Burke, chapter delegate, reviewed the agenda for the Chapter Delegates Meetings at the coming Annual Meeting in Chicago.

Resolutions were adopted requesting the chapter delegate bring before the meeting the following points: (1) That arrangements be made to process all membership applications through the local chapter; (2) That a place be provided on membership applications for grade recommendations of the local chapter. Attendance 12. Attendance ratio 0.19.

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Golden Gate—February 3, 1949. After a short business session, the program chairman introduced Raymond Mancha, vice president, Joy Manufacturing Co., Pittsburgh, Pa., who spoke on *Vaneaxial Fan Fundamentals*. During the business part of the meeting it was announced that the March 3 meeting would be held at the University of California, Berkeley, with Prof. N. W. Snyder presiding.

On March 24 chapter members are to be guests of the *ASME*, where the speakers will be R. W. Shoemaker and Robert Bruen. Attendance 95. Attendance ratio 0.31.

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Golden Gate—January 6, 1949. Slides illustrated the talk by T. A. Marshall at the Engineers Club, San Francisco. Mr. Marshall spoke on *Industrial Air Conditioning for Cold Storage Applications*. Pres. H. V. Hickman reported the resignation of John Everetts, Jr. from the Board

* Note: The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

of Governors, due to his change of address to Washington, D.C. The secretary was instructed to write Mr. Everetts stating its appreciation of his efforts. T. J. White was unanimously elected to replace Mr. Everetts on the Board of Governors. Attendance 48. Attendance ratio 0.21.

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Illinois—February 14, 1949. Boilers were prominent in the speaker's portion of the chapter meeting. Fred Meyer of Midwest Heat Service, discussed *Heating Boilers and Firing Methods*, describing various types of cast iron and steel boilers. Boiler design was emphasized by Mr. Meyer, together with an explanation of current ratings as contrasted with ratings of the past. He also discussed such fuels as oil, gas and coal.

F. W. Hainer, Cleaver-Brooks Co., next talked on *Package Boilers*, using slides to demonstrate the history of the boilers. He stressed wartime application as well as current uses and problems concerning this particular type of heating unit.

H. D. Valentine, People's Gas Light and Coke Co., Chicago, spoke on the availability of gas now and in the future. W. L. Leavitt, Standard Oil Co. of Indiana, discussed the availability of oil and also outlined oil problems relating to the heating industry.

The subjects of *Heat Pump* and *Electrical Panel Heating* were announced as the program for the March meeting. Other business included a report on the activities of the Committee on Arrangements at the recent Annual Meeting. Attendance 126. Attendance ratio 0.22.

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Illinois—January 10, 1949—W. A. Kuechenberg introduced the chairmen of his various committees, who in turn reported on their activities regarding the 55th Annual Meeting. The speaker of the evening, introduced by L. H. Streb, was Dr. J. E. King, industrial psychology consultant, Chicago. Dr. King discussed methods of measuring personnel and their effect on customer relationship. He explained in some detail the amazing results of such tests as they applied to the prediction and measurement of old employees as well as potential employees. He outlined a number of methods for job measurement concerning rate of pay and type of personnel requirements. Attendance 110. Attendance ratio 0.26.

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Indiana—January 28, 1949. A social hour preceded the dinner, after which the meeting of the Indiana Chapter was called to order by Pres. P. R. Jordan. President Jordan spoke briefly on the possibility of forming an Indianapolis Engineers Club.

Two members of the Purdue Student Branch were introduced, and it was announced that the February meeting would be held jointly by the Indiana Chapter and the Purdue Student Branch.

G. D. Winans, assistant superintendent of central heating, The Detroit Edison Co., Detroit, Mich., gave a talk on the *District Heating Service in Detroit*. He described the use of district heating for steam jet cooling and absorption cooling systems of air conditioning, which would give district steam systems a more balanced load. The meeting was formally adjourned at 9:10 p.m., followed by an informal half hour of question-and-answer period. Attendance 36.

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Iowa—February 8, 1949. At the Des Moines Club, Des Moines, Ia., Prof. Frank Kerekes, Iowa State College, Ames, spoke on the *Building Code Law*, which is now before the Iowa Legislature.

D. E. Wells, program chairman, introduced the speaker, J. A. Boland, Jr., Universal Fabricated Products Co., Chicago, who spoke on *Condensate in Building Construction and Ways to Overcome It*. He illustrated the effect of various types of insulation materials from the standpoint of moisture barriers and the reason for condensation in building walls.

Four Iowa State College students were guests for the evening. Attendance 41. Attendance ratio 0.71.

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Iowa—January 11, 1949. M. E. Gould reported on the Society's research program, and D. E. Schroeder reported on the Heating and Ventilating Short Course to be held at Ames, Ia. J. E. Haines, chairman of the Society's Nominating Committee, and vice president of Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., outlined the background of tests and developments in railroad car heating, ventilating and air conditioning. Mr. Haines then introduced Dale Wismuller, of the same firm, who spoke on the history of heating equipment used in railroad cars and outlined the present floor heat and control system. He made a few predictions of future equipment and expected progress in dehumidification, radiant heating and cooling, modulating controls for cooling, heated glasses, elimination of cold air in the car, and elimination of steam lines through the train. Attendance 29. Attendance ratio 0.65.

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Kansas City—February 7, 1949. Activities in connection with the Student Branch at the University of Kansas were reported on by C. W. Schumacher at the regular meeting held in the Pine Room at Union Station. K. M. Stevens as chapter delegate, told members of the Chapter Delegates meetings at the Annual Meeting in Chicago.

Air Conditioning Problems in stores throughout the United States were described by B. A. Jacobi, chief engineer of the Lerner Stores Corp., New York, N. Y. Many questions were asked by the audience at the close of Mr. Jacobi's talk. Attendance 67.

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Kansas City—January 3, 1949. During the meeting in the Pine Room at Union Station, C. R. Davis reported the death of Mrs. John H. Kitchen. It was recalled that Mrs. Kitchen was one of the ladies who helped to entertain the ladies during the Annual Meeting of the Society in 1941. E. K. Campbell suggested that the secretary write a note of condolence to Mrs. Kitchen's son, F. A. Kitchen, Cleveland, and a copy be sent to S. R. Lewis in Chicago, her brother.

D. M. Allen introduced H. E. Degler, technical director, Marley Co., Kansas City, who gave a most interesting talk concerning water-cooling towers for refrigeration and air conditioning. Mr. Degler described the development of water-cooling equipment and presented illustrating slides.

J. F. Long, Yarnall-Waring Co., St. Louis, presented a film called *There is an Engineering Reason*. Attendance 54.

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Manitoba—February 17, 1949. This meeting was held at the Fort Garry Hotel, Winnipeg. The business portion of the meeting included reports by Pres. J. R. Stephenson on research, and Sec'y D. F. Michie on student membership.

The speaker for the March meeting was announced as F. L. Morton, engineer, City of Winnipeg, who would speak on the subject, *The Use of Water in Air Conditioning*.

G. C. Davis introduced the guest speaker, F. W. Satchwill, manager, gas sales, Winnipeg Electric Co. Mr. Satchwill spoke on the subject of *Natural Gas for Winnipeg, Prospects and Problems*. He pointed out that a natural gas pipe line from present proven fields in the Calgary area was not an immediate probability, but that there were possibilities for finding producing fields nearer Winnipeg in which event natural gas would very probably become available here. He then outlined some of the operational problems that would have to be met. The experience of some other cities in changing over from manufactured to natural gas distribution was outlined and an estimate was made of the extent and type of load the utility would be able to handle. Attendance 19. Attendance ratio 0.37.

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Manitoba—January 20, 1949. Visitors were introduced by J. R. Stephenson, while outside, the temperature was 40 deg below zero. Vice Pres. A. W. Moss then introduced F. W. Taylor of the Ontario Chapter who conveyed greetings from his Chapter. D. P. Kenney was appointed Chapter Delegate in place of Secretary Michie, who would be unable to attend the Annual Meeting.

District Heating of the Downtown Section of Winnipeg was the subject of the talk given by R. A. Stewart, Engineering Department, City of Winnipeg, Hydro Electric System. Using slides, Mr. Stewart stressed the development of the municipally owned district heating system since its inception in 1924 and explained its problems, methods and operation. Attendance 23. Attendance ratio 0.39.

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Massachusetts—January 18, 1949. The meeting was preceded by the usual group dinner in the Campus Room of the MIT Graduate House. Pins were presented to the following past presidents of the Chapter: H. C. Moore, J. W. Brinton, E. G. Carrier, D. M. Archer, C. W. Larson, Adolph Ehrenzeller, Prof. James Holt and Prof. C. P. Yaglou.

E. G. Carrier, chapter representative on the Society's Committee on Promotion of Research, spoke on the research activities of the Society. Henry Sleik, vice-president of W. B. Connor Engineering Corp., New York, N. Y., spoke on *Odors—Their Nature, Cause and Control*. Attendance 47. Attendance ratio 0.44.

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Memphis—January 17, 1949. A talk on *Baseboard Panel Heating* was given by R. H. Weigel, speci[illegible] research assistant, University o[illegible] Illinois, Urbana, Ill., at the d[illegible]nner meeting held at the King C[illegible]tton Hotel. Pres. E. E. Scott read a [illegible]tter from Ralph Philips, regardin[illegible] Society research, and W. E. T[illegible]horpe announced that a representative of the Worthington Pump & Machinery Corp. would be the speaker at the next meeting. An open discussion period followed the talk by Prof. Weigel. Attendance 36. Attendance ratio 0.56.

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Michigan—February 14, 1949. C. A. McKeeman, assistant to the president of the ASHVE, Cleveland and L. P. Saunders, chief engineer, Harrison Radiator Division, General Motors Corp., were guests at the dinner meeting in the Horace A. Rackham Bldg. in Detroit.

Following dinner, reports were made by Treas. C. F. Donohoe and Vice-Pres. L. A. Burch. J. N. Livermore reported activities of the *APELSCOR*, with J. J. Uicker, chapter member, as secretary of the committee. Mr. Livermore described the advisory work of the Architects, Professional Engineers and Land Surveyors.

President Hyde stated that 58 members of the Michigan Chapter and their wives attended the Annual Meeting. Three members, G. H. Tuttle, R. F. Connell and Fred Bishop were appointed members of the chapter's nominating committee.

President Hyde also reviewed prospects for a student branch at the University of Detroit.

Eighteen of the 24 living past presidents were present. E. M. Harrigan, an original charter member of 1915, was also present.

Speaker was W. N. Witheridge, ventilation consultant, General Motors Corp., Detroit, on *Recirculation of Air from Industrial Exhaust Systems*. A question and answer period followed. Attendance 86.

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Michigan—January 17, 1949. Continuing a practice of 19 years. The

Detroit Edison Co. entertained the Michigan Chapter with the annual dinner and movies. C. F. Donohoe, technical engineer, representing the host of the evening, welcomed members and guests, and introduced E. E. Dubry, past president of the chapter. Mr. Dubry than introduced W. R. Milby who spoke on *Television in the City of Detroit*. He presented films showing how television is programmed, and discussed the problems of installing proper antennas, of choosing proper receiving sets, of the present trend in receiving set design, as well as the transmitting stations expansion program. A full length movie was also shown. Attendance 134.

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Minnesota—January 1949. At the Curtis Hotel, Minneapolis, a joint dinner meeting was held with the Minnesota Chapter of *ASRE*. E. R. Ambrose, air conditioning engineer, American Gas and Electric Service Corp., New York, N. Y., spoke on the *Development of the Heat Pump*. He used a chart showing comparative operating costs for various types of fuel compared with heating by means of heat pumps. Entertainment was furnished by the entertainment committee and the entire assembly engaged in group singing. Attendance 235.

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Montreal—January 13, 1949. Discussion during the meeting at the Berkeley hotel included the research questionnaire and associate membership. Past president's pins were presented to A. M. Peart and J. P. Fitzsimmons. Study of chapter by-laws preparatory to making changes was authorized by a vote of the members. Pres. Leo Garneau announced that the nominating committee would be A. B. Madden, *chairman*, and F. A. Hamlet and T. H. Worthington.

Speaker of the evening, Arthur Wilkinson, manager, The Wilkinson Engineering Agencies, gave a talk on *Airplanes I Have Known*. Attendance 36.

Nebraska—February 8, 1949. A report on the 55th Annual Meeting was given by L. A. Ferguson at the Regis Hotel, Omaha. O. J. Smith reported on membership, and F. E. Prawl spoke on research promotion.

Refrigeration and Cooling was the subject of the talk given by Prof. R. C. Jordan, assistant head, Department of Mechanical Engineering, University of Minnesota, Minneapolis. A general discussion followed. Attendance 40.

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Nebraska—January 12, 1949. *Fuels and Their Use* were discussed in a talk given by T. C. Cheasley, fuel engineer, Sinclair Coal Co. & Affiliates, Kansas City, Mo. Mr. Cheasley discussed coal as a fuel and also described methods of firing. He illustrated his talk with slides. A general discussion followed. Attendance 27.

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Northeastern Oklahoma—February 8, 1949. Following reports by the program committee, the treasurer and the chapter delegate to the Annual Meeting, B. A. Jacobi, chief engineer, Lerner Stores Corp., New York, N. Y., was introduced. He spoke on *Chain Store Air Conditioning*.

F. M. Thomas, program chairman, announced that the speaker for the next meeting would be L. S. Reagan, vice president and general manager, The Webster Engineering Co., Tulsa, and a member of the chapter, who would discuss *Combustion*.

A short talk was also given by Pres. W. R. Lee regarding the membership drive, with the slogan being *50 by '50*. Attendance 21. Attendance ratio 0.41.

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Northeastern Oklahoma — January 10, 1949. Business matters taken up at the meeting in the Oklahoma Natural Gas Bldg. included reports on the Annual Meeting and chapter representatives in research.

F. M. Thomas introduced the speaker, Fred Johnson, manager, Air Conditioning Division, Surface Combustion Corp., Toledo, Ohio. Mr. Johnson spoke on *Air Conditioning and Dehumidification*.

Announcement was made that the speaker for next month would be B. A. Jacobi, chief engineer, Lerner Stores Corp., New York, N. Y., who would speak on *Chain Store Air Conditioning*. Attendance 23. Attendance ratio 0.65.

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Northern Ohio—January 10, 1949. Nathaniel Glickman, assistant professor of medicine and research physiologist, Department of Medicine, University of Illinois, Chicago, and Cyril Tasker, director of research, ASHVE Research Laboratory, Cleveland, were the speakers at the meeting in the Warner Auditorium of the Cleveland Engineering Society Building. Professor Glickman spoke on *The Reactions of Cardiac Patients and Normal Subjects to Sudden Change in Environment*. With the use of slides, he pointed out results of the tests and the differences in physical reactions of the two groups. Mr. Tasker spoke on British research activities.

Dennis Boggs, chairman of the program committee, announced that the next meeting would be a heating specialties panel discussion featuring some of the Chapter's own talent.

R. E. Sherman gave the treasurer's report, and R. W. Dickson reported on membership. Attendance 65.

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Oklahoma—February 14, 1949. During the meeting at Beverly's Drive-In, Oklahoma City, Pres. J. H. Spaan, Jr., reported on the 55th Annual Meeting of the Society in Chicago.

E. R. Michel, assistant manager, Air Conditioning and Refrigeration Division, Worthington Pump and Machinery Corp., Harrison, N. J., spoke on the application and operating characteristics of centrifugal compressors used for air conditioning of public buildings. Attendance 45.

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Ontario—February 7, 1949. Dinner preceded the regular meeting at the Royal York Hotel, Toronto. A. J. Strain reported on the Chapter Delegates meetings in Chicago during the Annual Meeting.

A panel discussion was the feature of the evening, with the following professions represented: Norman McMurrich, *architects;* D. L. Angus, *consulting engineers;* G. A. English, *contractors;* and H. Tabbiner, *suppliers.* While Mr. Evans acted as chairman, the speakers discussed The *Architect, Engineer, Contractor, and Supplier in the Heating, Ventilating and Air Conditioning Industries.* Subjects brought out included building specifications, prices, contracts, etc. Following the talks, the meeting was thrown open for discussion. Attendance 123. Attendance ratio 0.56.

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Oregon—February 10, 1949. The election of J. Donald Kroeker to the ASHVE Council was acclaimed by members during the meeting at the Heathman Hotel. B. W. Farnes reported on the Inland Empire Chapter organizational meeting at Spokane.

The meeting was then turned over to J. P. McDermott, who as chapter delegate reported on the 55th Annual Meeting and the Exposition. Mr. McDermott said that W. Bruce Morrison had been elected to serve as secretary of the Society's Nominating Committee. Regarding the Chapter Delegates meetings, Mr. McDermott said that few chapters had definite matters to present and that Indiana and Oregon were exceptions. He stressed the importance of having a properly prepared presentation. Other matters discussed at these meetings were: Processing of Society membership applications; the research program; chapter dues; and patterns for chapter by-laws.

Mr. Kroeker reported on the attendance at the Annual Meeting and at the Exposition, and gave a resumé of council activities, including discussion of problems arising from increase in memberships.

Pres. E. R. Lokey gave his impression of the Exposition. L. J. Harrington and Ross Mudge gave reviews of two of the papers presented at the Annual Meeting. W. J. Widmer summarized meetings of the Committee on Panel Heating. Attendance 126. Attendance ratio 0.45.

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Oregon—January 6, 1949. A forum on *Panel Heating* with B. W. Farnes as moderator was the feature of the dinner meeting held at Heathman Hotel, Portland. T. E. Taylor first gave his opinion on the questions presented by the moderator and then any of the six experts agreed or disagreed with Mr. Taylor. The six participating were: W. J. Widmer, E. A. Murhard, Robert Baer, W. R. Norte, Les Copenhagen, and A. H. Bohren. J. Donald Kroeker and W. Bruce Morrison were special referees.

William Gehrs was presented to the group and received applause when Pres. E. R. Lokey announced that Mr. Gehrs had been honored by Johnson Service Co. for completing 50 years in its service. Attendance 98. Attendance ratio 0.51.

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Pacific Northwest — February 8, 1949. The February meeting was called to order by Vice-pres. J. D. Sparks in the absence of Pres. L. L. Bysom. Merrill Musgrave reported on a meeting of a group in Spokane in regard to forming a chapter there. Mr. Musgrave suggested that the Pacific Northwest Chapter offer assistance to this group.

Clint Lundy of Permanente Metals Co. spoke on the use of aluminum for duct work. A question and answer period brought about considerable discussion. Attendance 46.

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Philadelphia—February 10, 1949. Pres. J. O. Kirkbride presided at the meeting held in the Engineer's Club. Following a reading of the minutes and the treasurer's report, the speaker of the evening, Henry Sleik, was introduced. Mr. Sleik, vice president of the W. B. Connor Engineering Corp., New York, N. Y. spoke on *Odors—Their Nature, Cause and Control.* Attendance 56. Attendance ratio 0.24.

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Philadelphia—January 13, 1949. The meeting was held at the Engineer's Club in Philadelphia, with Pres. J. O. Kirkbride presiding. Since this meeting was the annual entertainment meeting, no business was conducted. Attendance 177. Attendance ratio 0.65.

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Pittsburgh — February 7, 1949. *Snow Melting* was the subject of the talk given by P. S. Park, Jr. at the meeting in Hotel Webster Hall. Mr. Park, who is manager, Engineering Service Department, A. M. Byers Co., Pittsburgh, described the various steps necessary to have a successful snow melting system, including labor, chemicals and disposal. He gave a formula for calculating the systems for the rate of 1 in. of snow per hour. Pipe sizes, distance between pipes and pattern type were discussed. The systems, said Mr. Park, could be operated either manually or automatically with intermittent or continuous operation. He illustrated his talk with slides showing systems operating in various parts of the country.

C. H. Schneider summarized events at the Chapter Delegates meeting in Chicago, and H. J. Kirkendall announced the program for the next meeting. Attendance 43.

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Rocky Mountain—January 5, 1949. The meeting was called to order by Pres. Fred Janssen, at the Olin Hotel. It was announced that the program for the noon luncheon of the Colorado Engineering Council on January 18, 1949, would be sponsored by the Rocky Mountain Chap-

ter said that P. J. Patch of the Public Service Co., Colorado, would speak on the *Effects of Altitude on the Combustion of Gases.*

E. J. McEahern, vice president and chairman of the program committee, then introduced the speaker of the evening, D. J. McQuaid, whose subject was *You Can't Live Ten Minutes Without It.*

He was speaking of air, of course. Since air is necessary to life, there must be some kind of air that is best, he said. The determination of what kind of air is best and how to produce that kind of air has required much study—and much remains to be done. It has been apparent for years that the dry bulb thermometer cannot by itself indicate the comfort conditions. With inside and outside dry bulb temperatures of 72 F and 10 F respectively, single-glass windows will be *steamed* if the inside conditions are within the comfort zone. The human body loses heat by convection, radiation and evaporation, and these losses are affected by the temperature and the moisture content of the surrounding air and by the temperature and radiating characteristics of surrounding objects. An experimental study at Cragmore Sanitorium demonstrated the effects of barometric pressure, temperature and humidity upon patients and hospital personnel.

A tray of vegetables on the speaker's table was used to illustrate the effect of evaporation upon the temperature of a body. Embedded etched-stem thermometers indicated the following temperatures: radish—66 F; turnip—68 F; carrot—67 F; apple—76 F; onion—75 F; ripe banana—79 F; and cucumber—76 F. The rate of dehydration of these vegetables would be a function of their respective depressed temperatures. It might be said that the radish and the carrot are *less comfortable* than the apple.

In addition to controlling the temperature and humidity of the air in which we must live, it is important to remove dust, dirt and bacteria. Mr. McQuaid predicted that air conditioning will in the future play a more important part in the prevention and treatment of disease. It is unfortunate, he said, that the home builder will object to the cost of providing air conditioning, but will approve considerable expenditures for purely decorative features. Mr. McQuaid illustrated his talk with a display of instruments and charts. Attendance 40. Attendance ratio 0.60.

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Shreveport—February 17, 1949. Reports on the 55th Annual Meeting were given at the meeting held in the Caddo Hotel. B. E. Segall, Jr., reported on the social side, S. W. Beaty on the technical session and A. H. Otto on the Chapter Delegates' meetings.

John E. Haines, vice president, Minneapolis-Honeywell Regulator Co., Minneapolis, spoke on *Advancement in Heating and Air Conditioning of Railway Passenger Cars.* Other members present from the firm were: Kent Wilson, Ralph Mixon and R. L. Patton. Fourteen engineering students of Louisiana Polytechnic Institute, Ruston, La., were also present, with two faculty members, Dean R. T. Sessums of the Engineering School and Prof. A. F. Williams.

A past president's pin was presented to W. E. FitzGerald. Attendance 54.

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Shreveport—January 13, 1949. Pres. A. H. Otto made a short acceptance speech to members gathered in the Caddo Hotel and also announced the chairmen and assistants of the different committees. W. E. FitzGerald spoke on membership goals for 1950, and Lester Hayes spoke on the airport question.

Guest speaker was J. W. May, director of research, American Air Filter Co., Louisville, Ky., who gave a talk on *Theory and Operation of Electrostatic Air Filters.*

Next month's speaker would be John E. Haines of the Minneapolis-Honeywell Regulator Co., it was announced. Attendance 38.

South Texas—January 21, 1949. A panel discussion on *Modern Gas-Fired Furnaces* was the feature at the chapter meeting in the Rice Hotel, Houston. B. P. Fisher presided over the discussions, which were given by C. A. McKinney, D. S. Cooper, A. B. Banowsky and Art Theobald.

During the business side of the program, R. J. Salinger, secretary, read a letter from the code committee of the chapter and a discussion took place among the members. A. F. Barnes reported on the January meeting of the Engineer's Council and C. L. Fleming reported on memberships, stating that the chapter is steadily growing in numbers.

Prof. A. A. Rasmussen, University of Houston, reported for the research committee and described research going on at the University. Attendance 86. Attendance ratio 0.30.

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Southern California — January 19, 1949. *Air Panel Heating in Southern California* was discussed by R. B. Bartlett at the meeting in Beverly Hills. Mr. Bartlett, a member of the consulting engineering firm of Hattis, Bartlett and Berky, showed slides illustrating the design data he used for jobs now in operation. An advantage of the air panels, said Mr. Bartlett, is that outside air can be introduced through the panels to reduce temperature in relation to the outside temperature changes experienced in the locality. Attendance 88.

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Southwest Texas—January 18, 1949. Vice-Pres. L. S. Pawkett presided over the meeting in the absence of Pres. G. R. Rhine. A report from F. C. Benham, Jr., chairman of the nominating committee, recommended that all present officers be retained in office for 1949 due to short terms of office in 1948. The report as presented was adopted by vote of the membership.

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R. D. Fink, sales supervisor, Servel, Inc., spoke on *The Gas Air Conditioning Unit* and the *Evaporation Water Cooling Unit*. The functions of the various assemblies together with operating characteristics were shown and capacities and costs were indicated.

Among the visitors were Fred C. Brandt and Robert McRoberts of the South Texas Chapter. Attendance 28. Attendance ratio 0.60.

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Utah—January 17, 1949. Pres. E. J. Watts called the meeting to order at Covey's Coffee Shop, Salt Lake City. D. R. Wilde, member of the legislature committee, reported on activities in the Utah Joint Engineering Council.

The guest speaker was Jack Davidson, manager, Stearns Rogers Corp., who spoke on *Power Boilers* and showed a sound, color movie on boilers—*Steam for Power*. The discussion that followed centered around the design, construction and operation of large capacity steam generators. Attendance 37. Attendance ratio 0.47.

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Washington, D.C.—February 9, 1949. The meeting at the Old New Orleans Restaurant followed a social hour and dinner. Pres. A. S. Gates, Jr., announced that a special meeting on March 18 would be co-sponsored by the Chapter and other technical Societies. The meeting would feature a report of the Hoover Commission recommendations and the effect on government engineers.

President Gates also reported on the Chapter Delegates' meeting in Chicago, and recommended experience be gained by delegates in order to take full part in the Annual Meeting.

H. W. Alyea, Johnson Service Co., spoke on *Getting the Most Out of Automatic Control*. He drew an analogy between a thermostat and a reducing valve and stressed the importance of proper balance of controllers and recorders. Various types of controllers with remote bulbs were explained. Attendance 52. Attendance ratio 0.24.

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Western Michigan — February 14, 1949. The annual ladies' night was called to order by Pres. H. W. Wolters at 6:50 p.m. in the Parchment Community House, Kalamazoo. The invocation was given by Dean Miller. A Valentine motif was used in table decorations and floral centerpieces and potted begonias added color to the dining room. A country style ham dinner was enjoyed by 108 members and guests, and a trio from Kalamazoo College provided dinner music.

Prof. C. H. Pesterfield spoke briefly of his activities in connection with his work on the Nominating and Chapter Delegates Committees at the Annual Meeting.

The members and guests adjourned to the auditorium and enjoyed a talk by Dr. J. F. Norton entitled *From Quinine to Penicillin or How Drugs Have Come To Be Used*. The meeting adjourned at 9:45 p.m. Attendance 108. Attendance ratio 0.38.

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Western Michigan — January 10, 1949. Dinner for 88 members and guests preceded the regular meeting at Grand Rapids. Following reports by the secretary and the treasurer, K. E. Robinson spoke on the research questionnaire. Speaker of the evening was D. F. Bennett, of Warren Webster & Co., who spoke on *Design, Installation and Performance of Baseboard Heating*, and a lively discussion followed. Attendance 80. Attendance ratio 0.52.

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Wisconsin—January 17, 1949. The January meeting of the Wisconsin Chapter of the ASHVE was held at the University Club, Milwaukee, with 64 members and guests present for the social hour followed by dinner. The meeting was the annual Ladies Night meeting and following dinner the speaker of the evening, Capt. F. J. Granfield, USN (Ret.), Great Lakes Naval Training Station, was introduced by Pres. W. A. Ouweleel.

Captain Granfield spoke on *Recruit Training at Great Lakes*, the activity of which he has directed. The talk was followed by a training film on *recruit training*. A second film entitled *The Silent Service*, which the Captain stated he had brought with him by popular request was also shown.

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Student Branches

North Carolina State College—February 8, 1949. R. S. Dill, chief of the Heating and Air Conditioning Section, National Bureau of Standards, Washington, D. C., returned to his alma mater as an honored guest and speaker when he addressed the North Carolina State College Student Branch of the ASHVE on Tuesday, February 8, 1949.

Mr. Dill spoke on *The Control of Condensation in Buildings*. The speaker outlined the factors that lead to condensation with its attendant troubles and dangers. This problem is becoming more acute as the building public and home owners are using more insulation due to the high cost of fuel. Mr. Dill offered ventilation and the proper use of vapor barriers as the two most promising means for controlling condensation. He compared the relative merits of the various types of insulation commonly available to the home owner. This section of his address was illustrated with slides.

Mr. Dill supplemented his prepared address by answering questions from the floor. During this period he outlined the work being done on solar heating. Attendance 40. Attendance ratio 0.66.

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North Carolina State College—January 11, 1949. The January 11 meeting in Raleigh was devoted entirely to an address by James Marshall

associate engineer with P. L. Davidson, consulting engineer, Greenville, S. C., and Philadelphia, Pa., who spoke on *Textile Air Conditioning*. Students and faculty members of the Textile School on the campus were guests of the Student Branch. An abstract of Mr. Marshall's talk follows:

The Textile Industry has always been conscious of and receptive to humidification and recently air conditioning. In its infancy, the textile industry attempted to control humidity by water troughs strategically placed throughout the mill floor. As power consumption of looms and spinning machines increased, the mills were faced with a need for refrigeration in addition to the humidification requirements. In 1915 when it was not uncommon for spinning rooms to reach a temperature of 120 F, the air change system using saturated air was introduced.

From this beginning in air conditioning, the systems have grown more complex as the process conditions have become more exacting. Various mills today are experimenting with effective temperature to increase personnel efficiency.

Mr. Marshall followed his survey of air conditioning in the textile industry with a cost analysis of a system for a New England textile mill. Members of the textile school faculty joined with the students in a spirited question and answer period. Attendance 54. Attendance ratio 0.86.

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Purdue University — January 12, 1949. At the regular meeting in the Mechanical Engineering Bldg., the following were elected to fill the vacancies in the executive committee: C. M. Wade, J. W. Roberts, and C. H. Salman.

W. D. Redrup, chairman of the Majestic Furnace Co., Huntington, Ind., spoke on *Warm Air Heating*. Mr. Redrup used slides to support the material presented, and pointed out features of the warm air panel heating system. Attendance 61. Attendance ratio 0.44.

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Texas A. & M. College—February 10, 1949. Various business matters were attended to at the meeting presided over by Pres. C. V. Brown. A membership committee was appointed, and a letter from the Agronomy Society was read, which invited the Student Branch to participate in the coming Cotton Ball and Pageant.

C. P. Howard spoke on the 55th Annual Meeting and told the group of the talks to be made by him and R. S. Segall to the chapters which had helped student members to attend the Annual Meeting. Cooperation of the A. & M. Student Branch for next year's Annual Meeting in Dallas was voted by the members. Attendance 18. Attendance ratio 0.27.

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Texas A. & M. College—January 18, 1949. Pres. S. E. Ammons called the meeting to order, and election of officers for the coming semester was held. The following were elected: C. V. Brown—*President;* H. J. Bettencourt—*Vice President;* R. N. Hughes—*Secretary;* Wendell Scott—*Treasurer;* and Julius Blum—*Parliamentarian*. Retiring president Ammons then turned the meeting over to President Brown.

Prof. L. S. O'Bannon announced that a $100 award would be given to the student from Texas A. & M. or the University of Texas who presented the best paper on *Why I Chose Air Conditioning Engineering for a Profession*. This award is to be made when the paper is delivered at the forthcoming Air Conditioning Conference to be held at Texas A. & M. College the latter part of March. Professor O'Bannon stressed the honor that would be gained from winning this award and offered his assistance to any of the members who were interested. Attendance 25. Attendance ratio 0.42.

OBITUARIES

Eugene Field, Jr.—The Society has been informed of the death of Eugene Field, Jr., member of Texas A. & M. Student Branch. Mr. Field died suddenly in December of a heart attack.

He was born November 7, 1922, at Calvert, Tex. He received his education at Calvert High School, and was a student at Texas A. & M. College, where he was majoring in mechanical engineering.

Walter A. Mertz, 51 East Grand Ave., Chicago, died in January at the age of 70. Mr. Mertz had been a Member of the Society since 1919.

He was born in Baltimore, Md. in 1879. Upon graduation from high school he became associated with the Kehm Brothers Co., Chicago, where he worked on heating, ventilating and power plant design, construction and operation.

He continued with the Kehm Brothers Co. until the time of his death.

William A. Weber—Minneapolis, Minn., died on January 8, 1949, at the age of 41. Mr. Weber was born on December 22, 1907, at Osawatomie, Kans. Following graduation from Osawatomie High School, he attended the University of Kansas and later the University of Minnesota, where he received his B.S. degree in mechanical engineering.

In 1935 he became a sales engineer for Bell & Eiss, Inc., Minneapolis. Seven years later, he joined Smith, Hinchman & Grylls as assistant chief mechanical engineer at the Eau Claire Ordnance Plant, Eau Claire, Wis. There he actively supervised the design of heating, ventilating and piping systems for air, oil, water, gas and steam for the project. In this work he was associated with U. S. Army engineers.

Other experience included work as senior engineer for Phillips Petroleum Co., in Oklahoma and Texas. In 1944 he returned to Bell & Eiss, Inc., as sales engineer and held this position until the time of his death. He was a registered professional engineer of the State of Minnesota.

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Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applications for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When the replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 113 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge members to assume their share of responsibilityof receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by April 25, 1949, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ALLEN, T. W., Mech. Engr., Corps of Engineers, Dept. of Army, Tulsa, Okla. PROPOSERS: L. S. Reagan, W. R. Lee. SECONDERS: G. C. Bergtholdt, F. M. Thomas.

ANDERSON, D. B., Mgr., Merchandising Dept., Wood Conversion Co., St. Paul, Minn. (*Advancement*). PROPOSERS: A. B. Algren, R. C. Jordan. SECONDERS: B. H. Jennings, F. B. Rowley.

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Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Third Wednesday. President, R. S. Farr, 2615 Southwest Dr., Los Angeles. Secretary, L. J. Helms, 633 S. Berendo St., Los Angeles 5.

Southwest Texas: Organized, 1946. Headquarters, San Antonio, Tex. Meets, Second Tuesday. President, G. R. Rhine, 1208 Alamo National Bldg., San Antonio. Secretary, I. W. Wilke, 422 Congress Ave., Austin.

•

Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, E. J. Watts, 2485 Douglas St., Salt Lake City 5. Secretary, R. H. East, 326 E. First So., Salt Lake City.

•

Virginia: Organized, 1946. Headquarters, Norfolk, Va. President, J. E. White, 7607 Gloucester Ave., Norfolk 5. Secretary, D. E. Phillips, P. O. Box 674, Newport News.

•

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, A. S. Gates, Jr., 621 N. Jackson St., Arlington, Va. Secretary, J. G. Muirheid, 2013 New Hampshire Ave., N. W., Washington 9.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, H. W. Wolters, 820 Staples Ave., N.W., Kalamazoo 54. Secretary, H. R. Limbacher, 760 E. Vine St., Kalamazoo.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, Edwin Woolcock, 2217 15th St., Niagara Falls, N. Y. Secretary, T. F. Killeen, 374 Delaware Ave., Buffalo 2.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, W. A. Ouweneel, 514 E. Ogden Ave., Milwaukee 2. Secretary, H. F. Brinen, 2226 Kinzie Ave., Racine.

Student Branches

North Carolina State College: Organized 1948. Headquarters, Raleigh, N. C. President, J. G. Marshall, North Carolina State College. Secretary, Basil Greene, Apt. D-2, Grosvenor Garden Apts., Raleigh.

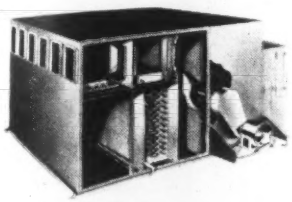
Purdue University: Organized 1948. Headquarters, W. Lafayette, Ind. Chairman, M. E. Naftzger, FPHA 228-2, State St., W. Lafayette. Secretary, C. M. Wade, The Maples Trailer Camp, Lafayette.

Texas A. & M. College: Organized, 1946. Headquarters, College Station, Tex. Meets, Third Thursday. President, C. V. Brown, Mech. Engrg. Dept., Texas A. & M. College, College Station. Secretary, R. N. Hughes, Box 914, College Station.

EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1949 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Conditioner Handles Six Separate Zones

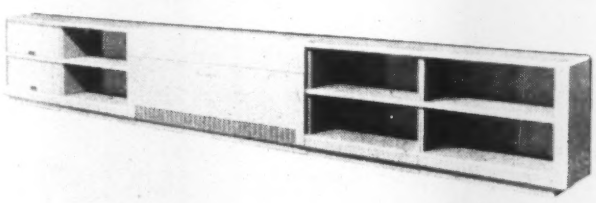


No. 4005—The "Multiple-Zone Climate Changer" is a blow-through type of conditioning unit designed by The Trane Co., La Crosse, Wis., to handle up to six zones or a minimum of one zone of a small or medium sized building or different floors of the same building.

According to the company, it is ideal for installations where one or more zones require little cooling or perhaps even heating, and the balance of the zones require maximum cooling. The unit contains a cooling coil, heating coil, fans, filters, humidifiers, dampers, and a plenum space which is partitioned into the number of zones required. Each space of the plenum is provided with two sets of dampers interconnected and controlled from a damper operated motor. One of the dampers admits heated air, the other cooled air. Any mixture of air can be admitted into each separate zone without affecting the heating or cooling in other zones.

Unit Ventilator Designed for Classroom Use

No. 4006—Offered in four basic sizes, the series 500 "Syncretizer" is a classroom unit ventilator designed for independent and either semi-recessed, nonrecessed, or window intake installation. The manufacturer is John J. Nesbitt, Inc., State Rd. and Rhawn St., Philadelphia 36.



Standard air ratings of the units are from 500 to 1200 cfm. In each of the models, three heating elements of different capacity are available for use with steam or hot water. The copper tube-aluminum fin elements are equipped with dual steam distributing tubes. The motor and fan assembly consists of a variable speed, double extended shaft motor with aluminum fans of forward curved design mounted directly on the motor shafts. A single blade roll type damper is used to control the proportions of outdoor and room air.

As shown here, the unit is available as a "package" with matching cabinets of either the open or closed type (and an auxiliary convector when desired).

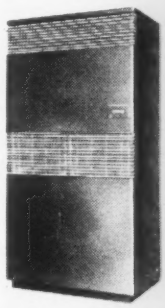
Limits Flow of Cooling Water

No. 4007—A new self operated, rigid stem type temperature regulator for limiting the flow of cooling water through engine and compressor jackets, hydraulic presses, vapor degreasers, condensers, etc. so as to maintain constant temperature has been developed by Sarco Co., Inc., Empire State Bldg., New York 1.

Warm water flows over the bulb which is rigidly attached to a valve in the cold water supply; the latter being piped to the bulb location. Noteworthy features are said to include the use of a closely balanced, double seated valve designed for accurate control without sticking and chattering and a separable socket so that the regulator may be removed for inspection without interrupting operation.

Units are available in sizes from $\frac{3}{8}$ to $1\frac{1}{2}$ in. for water pressures to 150 psi.

Packaged Conditioner Features Six Row Coil, Bypass Damper



No. 4008*—The new air conditioning unit developed by Brunner Mfg. Co., Utica, N. Y., has a six row cooling coil, a bypass damper, and is said to remove 61,000 Btu per hr with a ratio of latent to total heat removal of 38.7 percent when operating under standard ASRE rating conditions.

Other features are said to include the use of standard size air filters, a "low speed, open type" condensing unit, a water cooled condenser and subcooler, and a single wheel, low speed blower designed to deliver 1800 cfm. A steam heating coil is optional, and a cooling coil in the machine compartment is used to remove heat from the motor and compressor.

FOR YOUR CONVENIENCE

Heating, Piping & Air Conditioning **[4-49]**
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature

(Circle each number in which you are interested)

4005	4006	4007	4008	4009	4010	4011	4012	4013	4014
4015	4016	4017	4018	4019	4020	4021	4022	4023	4024
4025	4026	4027	4028						
7188	7189	7190	7191	7192	7193	7194	7195	7196	7197
7198	7199	7200	7201	7202	7203	7204	7205	7206	7207
7208	7209	7210	7211	7212	7213	7214	7215	7216	7217
7218	7219	7220	7221	7222	7223	7224	7225	7226	

Name..... **Title**.....

Company .....

Address .....

City..... **Zone**..... **State**.....

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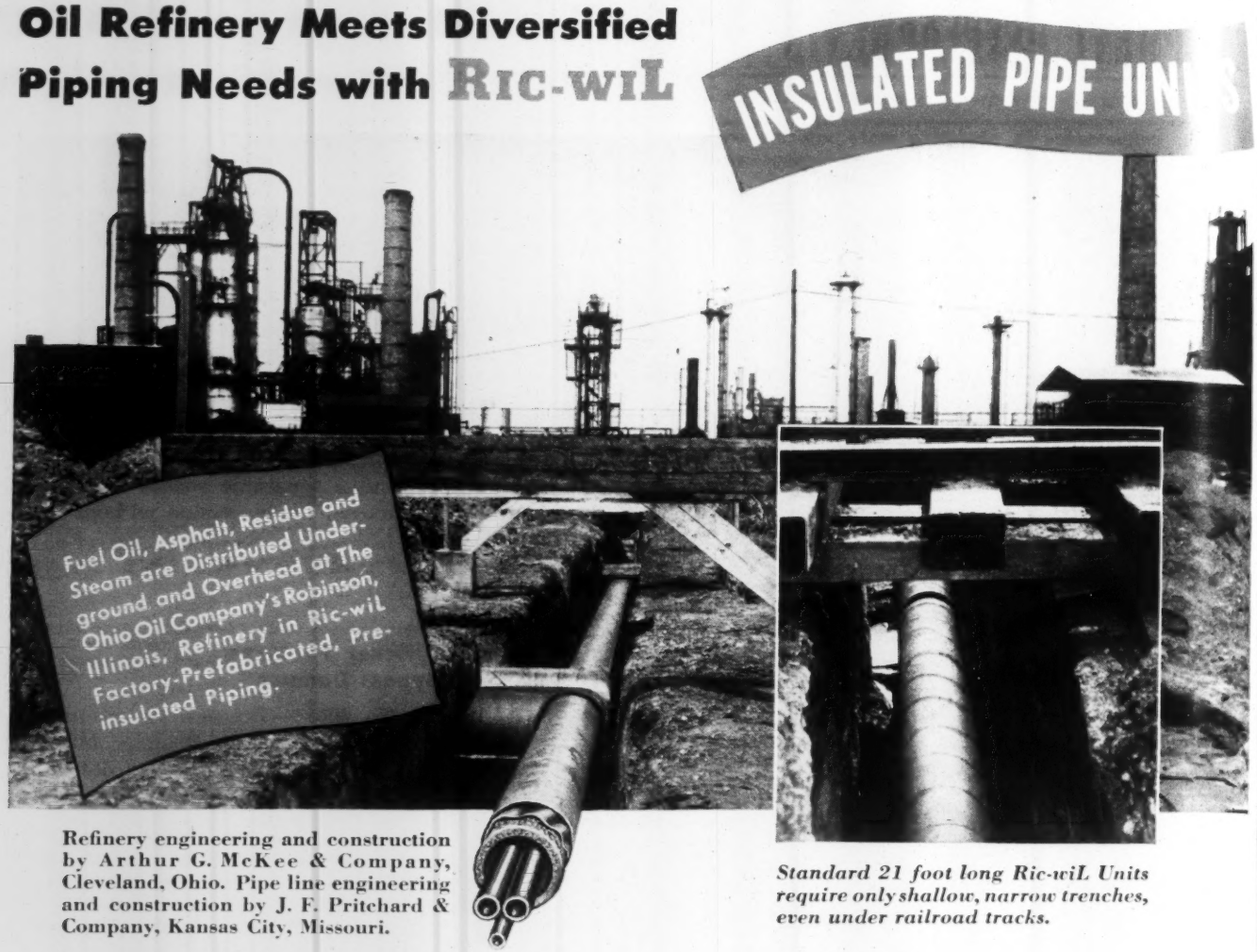
Oil Refinery Meets Diversified Piping Needs with Ric-wiL


INSULATED PIPE UNITS
Fuel Oil, Asphalt, Residue and Steam are Distributed Underground and Overhead at The Ohio Oil Company's Robinson, Illinois, Refinery in Ric-wiL Factory-Prefabricated, Pre-insulated Piping.

Refinery engineering and construction by Arthur G. McKee & Company, Cleveland, Ohio. Pipe line engineering and construction by J. F. Pritchard & Company, Kansas City, Missouri.

Standard 21 foot long Ric-wiL Units require only shallow, narrow trenches, even under railroad tracks.

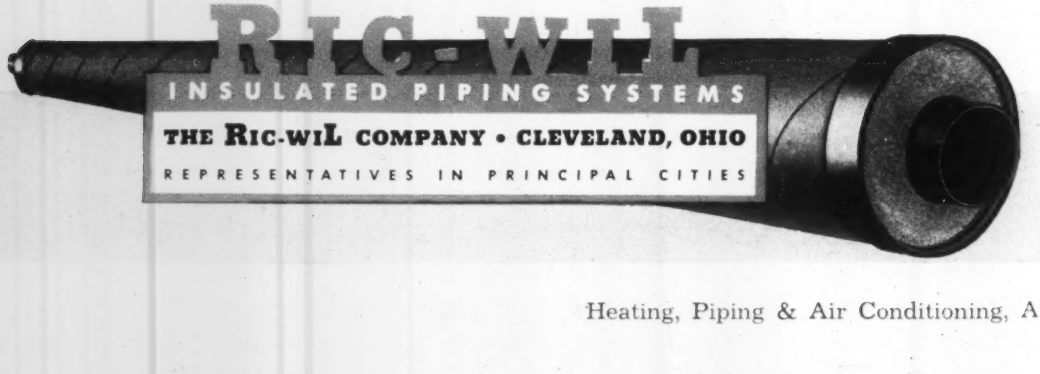
The adaptability of Ric-wiL Insulated Piping Systems to any type of piping requirement is ably demonstrated by this refinery installation. It consists of ten separate runs of prefabricated pipe units employing a wide variety of pipe sizes and pipe arrangements for distribution of steam and viscous fluids at various temperatures.

The temperatures required for the distribution of the various viscous fluids are efficiently maintained in Ric-wiL Uniline Insulated Pipe Units. In this type of construction, pipes carrying oil, asphalt, etc., are nested with a steam tracer inside an insulation liner which insulates them from the exterior but not from each other.

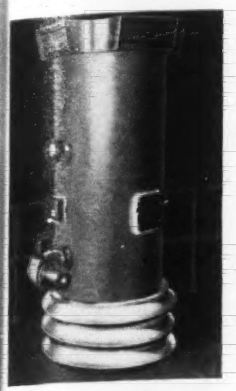
At Ohio Oil, many different viscous fluids are carried in 4″ and 6″ pipes at temperatures ranging from 125° to 400°F. Steam for tracer lines and processing is distributed in pipes of from 1″ to 6″ diameter at 150 psi, 450°F.

Pipes and insulation are housed in helically corrugated, 16 gauge galvanized ingot iron Hel-coR conduit, ranging from 8″ to 21″ in diameter. The inherent flexibility and strength of this conduit permits underground installation with only 3′-5′ cover, even under heaviest ground loads. Overhead installations require a minimum of scaffolding and supporting structures. Units may be connected on ground before being lowered into trench or erected for overhead suspension. Entire piping systems are delivered completely prefabricated with all accessories—elbows, tees, anchors, expansion loops, etc.—ready for speedy, low cost installation.

Ric-wiL manufactures three basic types of Prefabricated Insulated Piping Systems—Hel-coR, Foilclad and Cast Iron Pipe Units. Pipe, insulation, and protective covering are factory-tailored to individual specifications to meet any condition or requirement for outside piping distribution. For descriptive literature, full information, write: The Ric-wiL Company, Department 2-D.



Direct Fired Unit Heater Available in Smaller Size



No. 4009—The model 300 direct fired "Thermobloc" unit heater is now available from Thermobloc Div., Prat-Daniel Corp., East Port Chester, Conn.

Characteristics are said to be identical to those of the first model 550 unit (550,000 Btu per hr output) except that the new heater delivers 300,000 Btu per hr, is 7 ft high, is 30 in. in diameter, and weighs 800 lb. According to the manufacturer, the small diameter of this packaged unit permits installation in limited areas. It may also be used for circulating relatively cool air from the floor level to the working level, for drying, and for supplying temporary heat on construction jobs.

Thermal efficiency is said to be from 82 to 86 percent with No. 3 fuel oil or gas. Oil consumption is $2\frac{1}{2}$ gph.

Fuel Change-Over Feature in Packaged Steam Generators

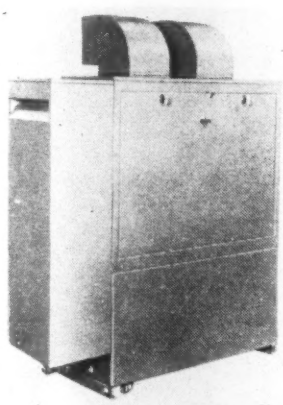
No. 4010—Changing from gas to oil, or vice-versa, can now be accomplished with the new automatic combination unit steam generators offered by Preferred Utilities Mfg. Corp., 1860 Broadway, New York 23.

The change-over from oil to gas, in units employing a horizontal rotary oil burner, is accomplished by swinging the oil burner open and inserting the primary gas burner in the normal oil burning firing port. This operation is said to require only a few minutes.

The primary burner is adjusted to handle 25 to 30 percent of the total maximum heat input and is supplemented by a main gas burner in the form of an annular ring which is always in place inside the furnace extension.

The company has also developed a combination gas and oil unit for the sizes from 20 to 70 hp which normally use a pressure atomizing type oil burner rather than the horizontal rotary type, the latter being used for units up to 500 hp.

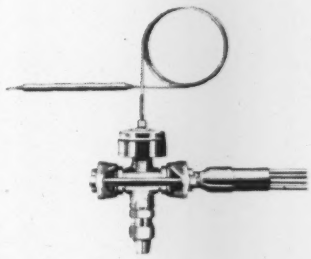
Develops Induced Draft Cooling Tower for Packaged Conditioners



No. 4011*—The model T101 induced draft cooling tower is particularly recommended by Airtemp Div., Chrysler Corp., 1600 Webster St., Dayton 1, for use with its packaged air conditioners.

Rated at 75,000 Btu per hr, it is designed for use with the company's 5 hp conditioner but is said to be adaptable for use with the 3 hp unit. The pump is rated at 15 gpm (38 psi discharge presure) and two centrifugal fans are used. The water tank and base are constructed of welded 11 ga steel and the tank is coated on the inside with black asphalt. A float valve controls the supply of make-up water and a connection is provided for wasting a specific quantity of water.

Thermostatic Expansion Valve Has Multi-Outlet Distributor



No. 4012—Any number of outlets up to 12 can be fed simultaneously from the model 216 thermostatic expansion valve developed by Automatic Products Co., 2450 N. 32nd St., Milwaukee 10.

Described as a compact "package" unit, it features a multi-outlet distributor designed to provide accurate, uniform feeding of refrigerant to the coil. The distributor is available in the straight or mushroom type and can be hooked to the valve after it is connected to the coil.

According to the manufacturer, the liquid charged valve can be mounted in any position or ambient temperature with no effect on bulb accuracy. It is equipped with an extra diaphragm unit to limit suction pressure to a 55 psi setting. This diaphragm counteracts the main diaphragm when suction pressure becomes excessive. The valve is set at standard superheat but has an adjustable range. Capacities are 3.6, 7, and 11 tons; with multi-outlet distributor, 3, 6.5, and 10 tons.

Designs Register to Blanket Outside Wall with Warm Air

No. 4013*—General Electric Co., Schenectady 5, N. Y., is marketing a new warm air register for installation above the baseboard on outside walls. It is designed to blanket the outer walls with warm air.

Developed for use with 4 in. round ducts, it discharges a fan-like pattern in front of the wall, yet several inches away from the wall no air movement can be detected, according to the company. The chief purpose in warming the wall is said to be to provide the sensation of radiant heat.

Approximately 30 percent less air is circulated in this "Air-Wall" heating system as compared to customary warm air systems as the air is supplied at somewhat higher temperatures and is mixed with room air as it leaves the registers. Use of these registers, together with the 4 in. round ducts, is said to reduce installation costs by as much as 50 percent.

Thermostatic Steam Trap Has Stainless Bellows

No. 4014—A stainless steel bellows, for pressure to 300 psi and for corrosive condensate, is a feature of the new line of thermostatic steam traps offered by Sarco Co., Inc., 350 Fifth Ave., New York 1.

Condensate and air venting capacity, says the company, are practically doubled through a new design which permits units to reach rated capacities with only a 10 deg drop from steam temperature.

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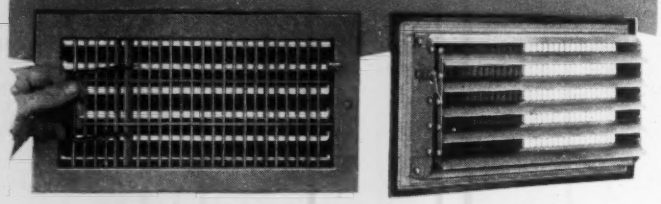
You can get

DIRECTED AIR FLOW

at any angle with

INDEPENDENT "Fabrikated" AIR CONDITIONING REGISTERS

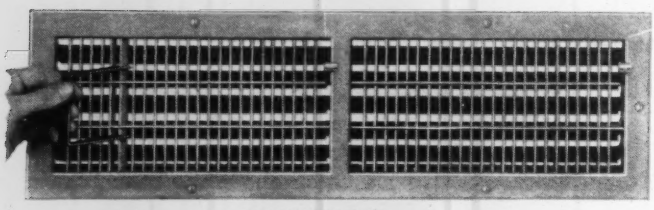
REG. U. S. PAT. OFFICE



321-A HMV

Rear View Showing "HMV" Valves

Every grille bar adjustable individually—before or after installation



321-A HMV Tandem

Any direction of air flow—right, left, up, down and any combination—is easily obtained with "Fabrikated" Style No. 321-A HMV air conditioning registers, for residence or commercial installations, on sidewalls or ceiling. The face bars are adjustable to right or left; valves on the back are adjustable to direct the air flow up or down; valves may also be fully closed, and are connected to open or close in unison.

The angles of deflection and the combinations to be had are practically unlimited. Adjustments for directed air flow may be made before or after installation. Grille bars are held firmly in place and will not vibrate or rattle.

"Fabrikated" registers are available in sizes from 8 x 4" to 48 x 24", including tandem style. Special sizes can be made without special die set-up charges.

Write for Catalog No. 48.

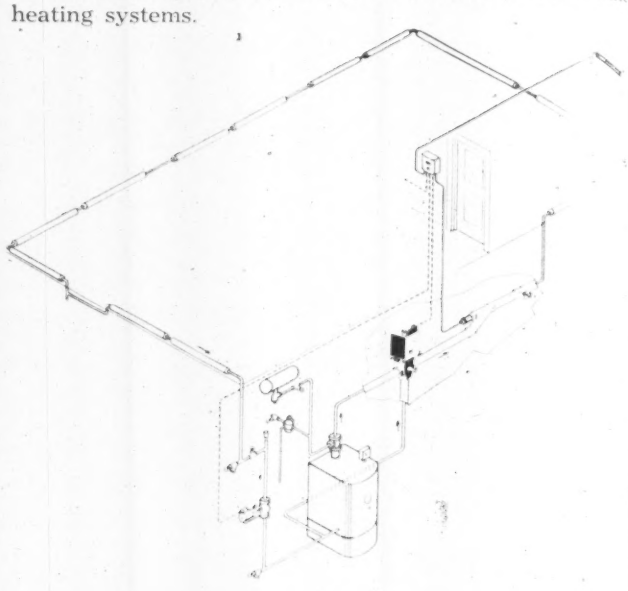
Always Leading—Always Progressing

THE INDEPENDENT REGISTER CO.

3747 E. 93rd STREET • CLEVELAND, OHIO

Provides Continuous Hot Water Circulation in Heating Systems

No. 4015—Consisting essentially of a control unit and a three-way mixing control valve, the type CF-2 [illegible]-stating control offered by Warren Webster & Co., Camden, N. J., is designed to provide continuous circulation in hot water heating systems.



The control unit incorporates an outside thermostat bulb and another bulb in the hot water supply main. It controls the mixing valve so as to maintain water temperatures in accordance with variations in outside temperatures. In addition, a switch on the unit may be set for automatic control, to shut off all heat, or to turn on full heat for rapid heating up. Optional equipment includes a single room thermostat, a time switch, and a duplex or day-night thermostat.

The control is designed to maintain a straightline relationship between outdoor and hot water temperatures, and the range of water temperatures may be adjusted for individual job requirements.

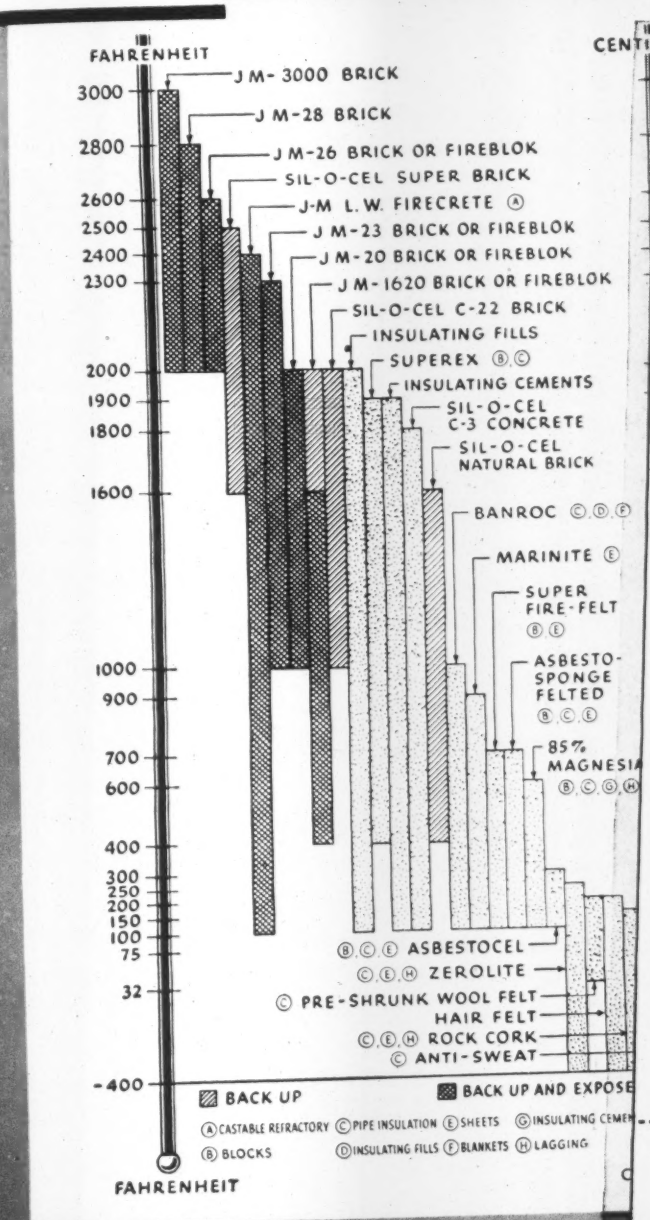
Compactness Features Diaphragm Gas Valve

No. 4016—White-Rodgers Electric Co., 1209 Cass Ave., St. Louis, Mo., is offering a new compact, diaphragm gas valve which is identical in length dimension with the company's solenoid valve. This is said to make it ideal for replacement and for equipment manufacturers to change over in production without delay or changing assembly parts.

Because of its compact size, it is recommended for various applications such as unit heaters, boilers, floor furnaces, etc. Manual operation with automatic recycling upon resumption of electric service is an optional feature. Furnished in ½ and ¾ in. sizes, the valve may be used on natural, manufactured, or mixed gas. It is also available on special order, for liquefied petroleum gas.

Ready reference chart...

Johns-Manville THERMAL INSULATIONS



Yours... for better insulation service!

Now, you can see at a glance the recommended insulation for every temperature range, from minus 400F to plus 3000F.

It's all on this convenient Johns-Manville Thermal Insulation Chart (11½" x 18") available for hanging in your office or on your plant wall.

Each insulation in this group of Johns-Manville products is tailor-made to do a specific type of job *best.* And, as part of the Johns-Manville Insulation Service, specialists are available to help you with present insulation problems . . . or with those connected with future plans.

By having these men select and apply Johns-Manville insulations, you will be dealing with men who have grown up in the business. You'll find that it will pay, in the long run, to have these experts help you... *because they have to their credit more man-hours of insulation application experience than all other similar types of organizations combined.*

For your copy of this chart, just fill in and mail the coupon below.

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Company_____

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Type 150 Suspended Unit Heater
60,000, 90,000, 120,000, and 150,000 Btu input capacities; for Natural, Manufactured, Butane-air, and LP-Gas.

NEW! with unique design features—

Mueller Climatrol

Gas-fired Suspended Unit Heater

. . . to meet a huge demand and bring extra sales to you

There is a constant demand for an attractive, compact, efficient, direct-fired gas unit heater — for use in stores, shops, theaters, garages, etc. And the new Mueller Climatrol meets that demand. Its special features give you an advantage over competition that will bring an extra volume of profitable sales to you. Here they are:

All-welded steel heat exchanger: Horizontal tubular design with high crown sheet; no impingement of flame. Completely cleanable from top or bottom without lowering unit.

Compact design — extra head room: Only 31" high, including diverter and flue vent, on 60,000 and 90,000 Btu sizes. Larger sizes are only 35½" high. Horizontal flue outlet on diverter.

Aerated flame burner: Cast iron with drilled ports. Single-opening shutter prevents clogging. Burner size increases proportionately with size of heat exchanger for uniform heat distribution.

Quiet, high-delivery blower: Discharge may be directed to suit installation by repositioning the adjustable louvers to blow horizontally or vertically.

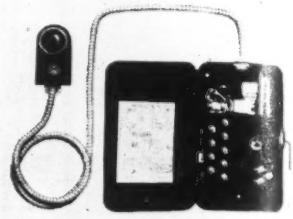
This addition to the Mueller Climatrol gas-fired line is shipped complete, pre-wired, ready for quick, easy installation.

It's a new sales-maker for you. Get behind it and you're sure to increase your sales volume and profits. Write for details. *L. J. Mueller Furnace Co., 2022 W. Oklahoma Ave., Milwaukee 7, Wisconsin.* E-37

MUELLER Climatrol
REG. U. S. PAT. OFF.

FOR GAS FOR OIL FOR COAL

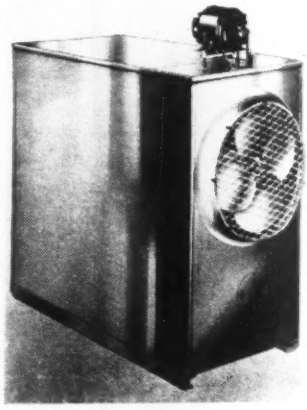
Control of Motors, Valves Among Photoelectric Cell Uses



No. 4017—The type 20DJ1 photoelectric control has been developed by Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass., for general industrial and machinery applications. It is said to provide automatic control for hundreds of specialized processes and to be particularly suited to short range signal systems, motor and valve control, machinery safeguards, stop motion control, and safety alarms.

The phototube, which is located where operations are to be controlled, is available either integral with the housing or in a small separate housing as shown here. A tamperproof sensitivity adjustment is said to permit positive operation over varying distances between the phototube and light source and under all conditions of ambient light.

Adds New Model to Line of Water Cooling Towers

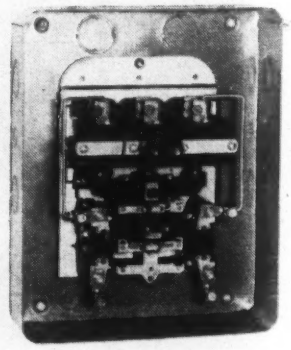


No. 4018—An "Aquatower" in the 7½ ton bracket has been added to the line of water cooling towers offered by Marley Co., Inc., Kansas City 15, Kans.

Like the other seven models, the new unit is said to feature compactness, quiet operation indoors or out, all-steel construction, grease packed ball bearings, and nail-less removable redwood filling.

All models are carried in stock.

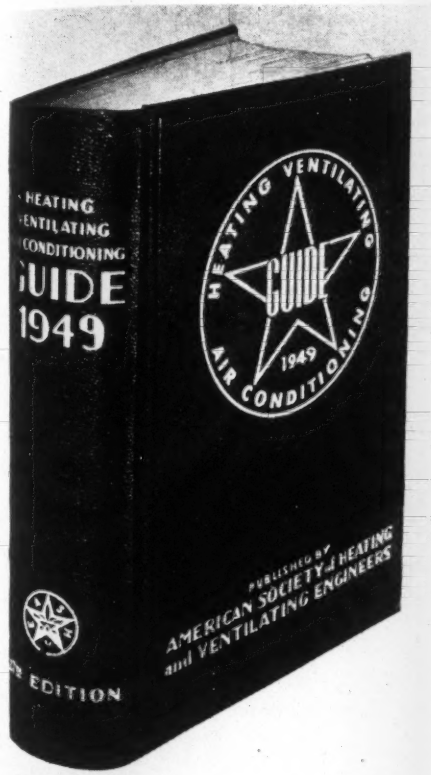
A-C Magnetic Starters Intended for General, Special Use



No. 4019—Ward Leonard Electric Co., Mount Vernon, N. Y., has designed Bulletin 4113 size 3 a-c magnetic starters for use in general and special purpose applications where across-the-line, nonreversing starting of polyphase squirrel cage induction motors and single phase motors is permissible.

These solenoid operated starters are available with open type construction for built-in or specialized controls, or with NEMA type I general purpose enclosures. They can be controlled by separate pilot devices or can be supplied with local control pushbuttons or switches.

Some of the outstanding features are said to include high arc interruption capacity, compact unit construction, reliable thermal overload protection, long operating life,



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AIR DISTRIBUTION—Illustrates methods of obtaining proper air flow and distribution. Formulas for air flow and charts for graphical solution of problems are included.

AIR DUCT DESIGN—Air Friction chart based on recent studies of A.S.H.V.E. Research Laboratory. Includes method of correcting for pipe roughness. Formulas and tables for circular equivalents of rectangular ducts.

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FLUID FLOW—Basic theory of fluid flow through pipe, nozzles, and orifices, presented clearly and concisely.

OWNING AND OPERATING COSTS—Shows method of establishing actual cost of air conditioning to the owner.

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REFRIGERATION—Simple presentation of the different refrigeration cycles, and brief treatment of most commonly used equipment arrangements and controls. Emphasis is placed on application of refrigeration.

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WARM AIR SYSTEMS—Gravity and forced circulation system design presented in accordance with latest accepted practice for both large and small systems.

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AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, 51 Madison Avenue, New York 10, N. Y.

Enclosed is $7.50 for standard edition of Heating Ventilating Air Conditioning Guide 1949; please send me a copy. It is understood that I may return it within 10 days, if it is not satisfactory, and you will refund my money.

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HP

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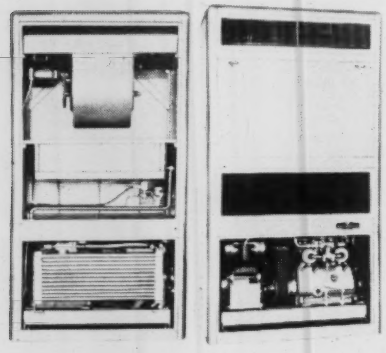
built-in solderless connectors, and double break silver-to-silver main contacts.

The maximum enclosed rating is 50 hp, 440-550 volts, 3 phase, 60 cycles. Standard operating coils can be supplied for 110, 208-220, 440, and 550 volt, 25 or 50-60 cycle service. Dual voltage coils can be furnished for 110/220 or 220/440 volt, 60 cycle operation.

Recommends Packaged Conditioner for Stores and Offices



No. 4020—Developed for a wide variety of applications, the model GR packaged air conditioner is particularly recommended for use in stores and offices. The manufacturer is General Refrigeration Div., Yates-American Machine Co., Beloit, Wis.

Capacities of the GR 312 and GR 520 units are 3 and 5 tons respectively. Features are said to include the use of a slow speed, reciprocating "Lipman" compressor, with a five row cooling coil of all-copper construction with fins solder bonded to tubes, a counterflow, double tube type condenser, an all-aluminum adjustable air discharge grille, and an unusually quiet centrifugal blower.

For winter use, a heating coil and humidifier are optional. The compressor motor is 3 phase and the blower motor is single phase; with 220 volt, 60 cycle current being standard.

Develops Small Steam Trap for Light Loads, Improves Others

No. 4021—The new "Super-Silvertop" No. 118 inverted bucket type steam trap has been developed by V. D. Anderson Co., 1932 W. 96 St., Cleveland 2, as a low cost unit for small drainage, light condensate load applications.

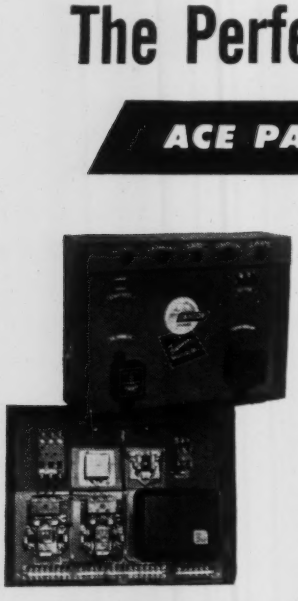
It is particularly recommended for use with unit heaters, pipe coils, sterilizers, coffee urns, steam tables, kettles, and laundry equipment.

It may be installed either as an elbow or straight-in-line. A blowdown plug and test plug are provided. With a capacity of 700 lb per hr (continuous flow) at 20 psi, it is recommended for pressures up to 150 psi and is available in the ½ in. size. Castings are of nickel semi-steel, the bucket and guide tube are of copper and bronze, and all working parts are of heat treated stainless steel.

Three other traps in the line have been improved. Nos. 110, 119, and 120. With increased capacity, they are designed to supplant previous models Nos. 10, 19, and 20.

The Perfect Oil-Burning Equipment Combination

ACE PANEL BOARD



The new all-steel Ace control panel permits rapid and efficient installation of oil burners.

It is pre-wired at the factory so that it is only necessary to supply the power and make connections on location. Wires are color-coded for ease in circuit tracing. Pilot lights indicate if burner is operating as desired.

The prefabricated panel has a number of other features that make it outstanding.

ACE Uniflow OIL BURNER

Ace burners are custom made for particular heating requirements, assuring dependable, economical, efficient applications in the commercial and industrial field.

The patented Ace Uniflow Valve permits a constant, uniform flow and flame regardless of changes in oil temperature or viscosity. The correct proportioning never varies.

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A special manual for architects and engineers is now available. Send for your copy today.

Ace UNIFLOW OIL BURNERS

Capacity Ranges

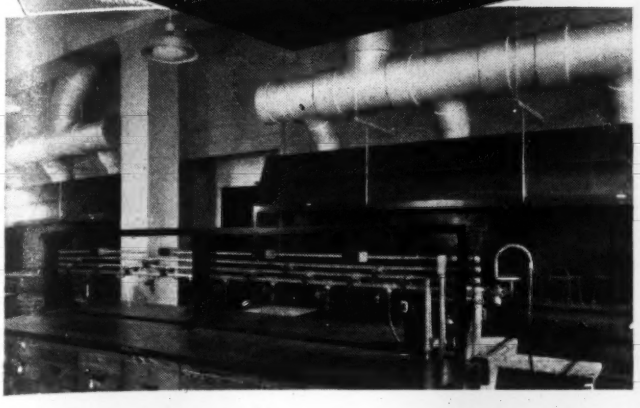
	Gallons Per Hour	Boiler H.P.	Square Feet Steam Rad.	Square Feet Water Rad.
Minimum	4	12	1,600	2,600
Maximum	165	500	64,000	104,000

ACE ENGINEERING CO.

1435 W. 15th Street • Chicago, Illinois

Custom Engineered Oil Burning Systems Since 1931

NO VENTING PROBLEMS HERE...



...with Transite Industrial Vent Pipe on the job

Transite* Industrial Vent Pipe was selected for this laboratory venting system because it resists the corrosive effects of many vapors, gases, fumes . . . because it will provide effective and economical venting service for years to come.

Transite makes up into neat, efficient venting systems for a wide variety of industrial uses. As vents, ducts, stacks, this asbestos-cement pipe is quickly and economically installed . . . is light, strong and durable. It is readily workable—can be cut and drilled on the job. Rustproof, it needs no painting whether used indoors or out.

Transite Industrial Vent Pipe comes in a range of sizes up to 36" in diameter. The full line of Transite fittings meets practically any job requirement and assures a venting system which is corrosion-resistant throughout. For further details, write for Data Sheet Series DS-336. Address Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

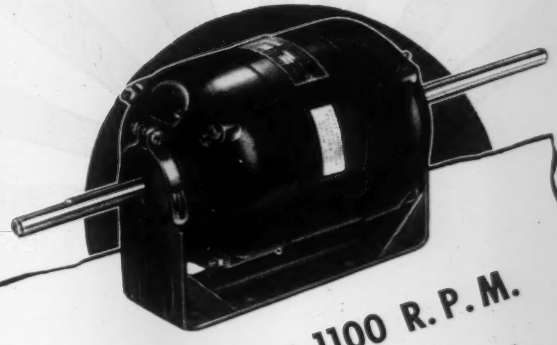
Typical Industries in which Transite Industrial Vent Pipe is used:

Aircraft	Foundry	Quarrying
Automobile	Furnace	Railroad
Baking	Furniture	Rayon
Bleaching	Gas	Refrigeration
Boiler Works	Glass	Rubber
Brewing	Laboratory	Shipbuilding
Canning	Laundry	Sewage Works
Ceramic	Leather	Shoe
Chemical	Meat Packing	Smelting
Dairy	Metal	Soap
Drug	Mining	Soft Drink
Electrical	Paint	Sugar Refining
Explosive	Petroleum	Textile
Farm Machinery	Potash	Tool
Food	Pulp & Paper	Water Works

*Reg. U. S. Pat. Off.

Johns-Manville TRANSITE Industrial Vent PIPE

Something NEW IN MOTORS



Up to ⅛ H.P. at 1100 R.P.M. with Low Cost Shaded Pole Motor Construction

The RAYTHEON Type 470

At last, something new in motors that helps you cut your production costs—both in lower motor prices and superior construction.

Raytheon Type 470 motors cost only ½ as much as comparable capacitor motors, ⅔ as much as split phase motors, yet they have the same, high quality frame design as the motors they replace.

Because the Raytheon *new principle* Type 470 motors have the highest efficiency ever produced in shaded pole motors it is possible to extend the benefits of low cost shaded pole construction to higher horsepower ratings than ever before.

Write today for Bulletin 4000 which describes in detail 18 outstanding features of this remarkable new motor.

RUSSELL ELECTRIC COMPANY
Subsidiary of Raytheon Mfg. Co.
340 West Huron Street Chicago 10, Illinois

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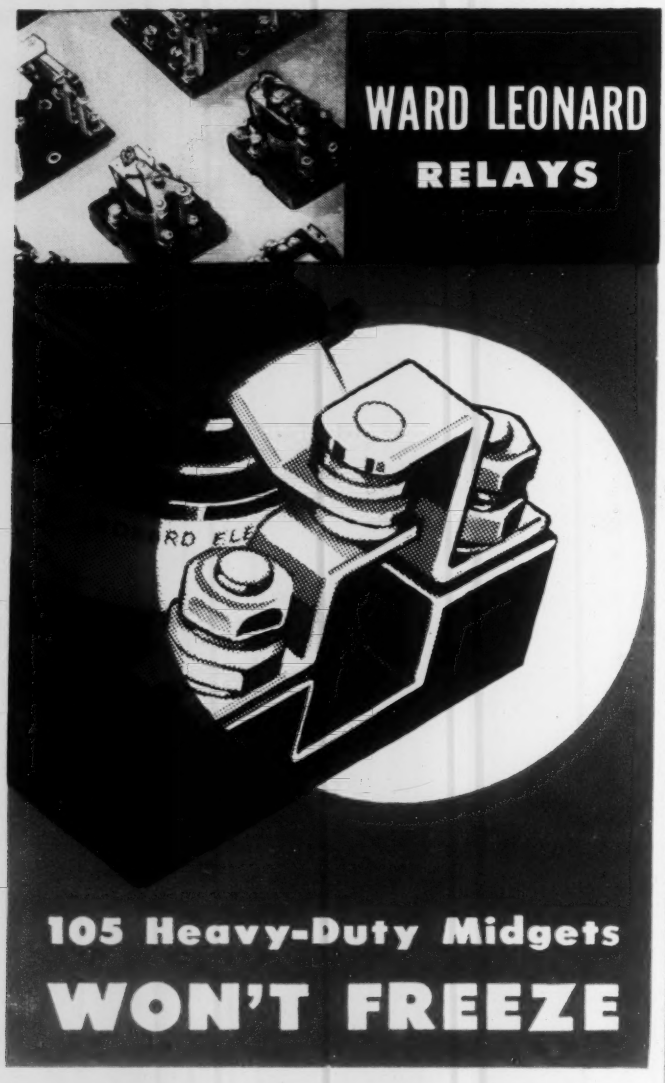

because contacts get a GENEROUS WIPE

Unique spring suspension adds a self-cleaning action to the heavy, silver-to-silver contacts of Ward Leonard's 105 Heavy-Duty Midget Relays. These features make them self-aligning, too.

Use Ward Leonard 105 Midgets on jobs normally requiring heavier relays.

Write for Relay Catalog. Ward Leonard Electric Co., 24 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

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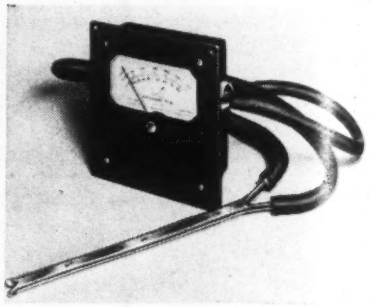
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

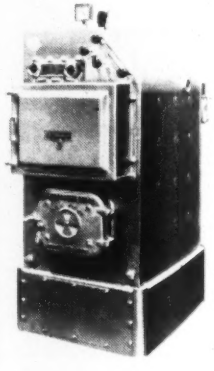
Flush Mounting of Air Velocity Meter Provides Permanent Setup



No. 4022—Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10, has announced a new flush mounted "Velometer" for permanent installation.

This new unit is said to be particularly suitable for permanent installation with permanent jets installed in ducts for continuous indication of air velocities. Minimum range is 0 to 1000 fpm; dimensions are 7 x 6½ x 2¼ in. One of the prime advantages, says the company, is the fact that there is practically a zero pressure drop through the instrument so that it is extremely accurate throughout its range. Special ranges may be furnished if desired.

Large Combustion Area, Two Pass Design Used in Steel Boiler

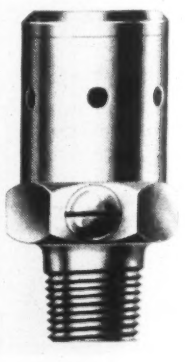


No. 4023—The "R-Z-U Junior" steel boiler offered by Fitzgibbons Boiler Co., Inc., 101 Park Ave., New York 17, is constructed in accordance with the ASME code, is rated on the basis of the SBI code, and is available in sizes from 1100 to 3000 net sq ft of steam for mechanical firing and from 910 to 2480 sq ft for hand fired coal.

The design is based on the company's older model of the same name but incorporates new features which are said to include a large combustion space, low draft loss, long flue gas travel of the two pass design and convenient grouping of controls for easy access.

The boiler may be used for steam or hot water and a submerged copper coil may be used for hot water supply.

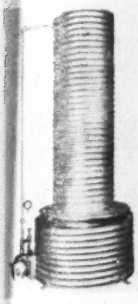
Vents Air from Hot Water Heating Systems



No. 4024—The "Taco-Vent" is an automatic air valve for venting radiators, baseboard units, convectors, and high points in hot water heating systems. The manufacturer, Taco Heaters, Inc., 137 South St., Providence 3, R. I., states that it not only eliminates manual venting but pays for itself in fuel savings.

Air passes through a special filter, a porous bronze plug, fiber discs, and vent holes to the atmosphere. Water, following the air, is cleaned by the filter, "slowed up" as it passes through the bronze plug and is sealed in the valve by the fiber discs which swell when in contact with the water. As more air accumulates, the discs dry and shrink, permitting the valve to again vent.

Water Spray Injects Air in Cooling Tower

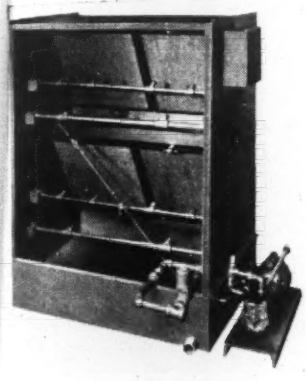


No. 4025*—In the new type J cooling tower developed by Baltimore Aircoil Co., Inc., 715-17 W. Pratt St., Baltimore 1, air circulation is accomplished by utilizing the force of water spray to inject the air.

The tower is available in the 3 and 5 ton sizes and the design is based on 3 gpm per ton with a 10 deg rise in water temperature and a 7 deg approach to the entering wet bulb temperature. Nominal rating is based on 78 deg W.B. temperature.

According to the company, the pumps furnished with the units are of the turbine regenerative type and have sufficient capacity to produce 80 ft head in excess of that required by the towers.

Air Filter Is Self Washing



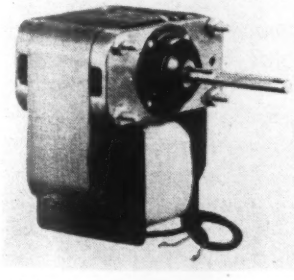
No. 4026—Automatic, self washing air filters have been developed by Farr Co., 2615 Southwest Dr., Los Angeles, Calif., and are designed for installation in most types of air conditioning systems.

Consisting of banks of standard 20 x 20 x 4 in. "Far-Air" filters inclined 30 deg toward the air flow, they are available in a variety of sizes. A series of automatically controlled water and oil nozzles on the entering air side of the filters periodically wash and re-oil the filter media. A constant displacement pump, controlled by the timer, delivers oil according to the number of filters in the bank. Once the cleaning and oiling interval is set on the controls, no further attention to the unit is necessary, the manufacturer claims.

The oil and water applied to the filters is not reused, but drains into the sewer. As an additional fire protection, a water valve is used to spray a continuous stream of water on the filter faces when dangerous air temperatures are reached.

The filter media is comprised of alternate layers of flat and herringbone crimp, 14 mesh, zinc electroplated screen which also acts as an oil and water eliminator.

Shaded Poles Feature Small Motor



No. 4027—Russell Electric Co., Chicago Div. of Raytheon Mfg. Co., 340 W. Huron St., Chicago 10, has used a 3½ in. square frame lamination in the design of its type 350, two pole motors which are offered in capacities from 1/25 to 1/10 hp, 3000 rpm.

Efficiencies up to 35 percent and starting torques up to 60 percent of full load torque are claimed for these shaded pole, skeleton motors. The manufacturer also claims unusually high horsepower output per pound and per dollar motor cost.

PATTERSON-KELLEY HOT WATER STORAGE HEATERS

Make it a "Copper-Lined" Heater and Save Money

We can and do manufacture hot water storage heaters of **all** commercially used metals. We make them of both ferrous and non-ferrous solid metals. But more and more the trend with our customers is towards copper-lined heaters.

The copper-lined heater offers just as much corrosion resistance or rust-prevention as solid copper or copper silicon. It is made to the same strength requirements and with the same factors of safety. **But it provides economy of construction** not possible with the solid non-corroding metals.

On your next hot water storage heater job, ask us about our copper-lined heaters. We'll be glad to quote on your specifications but do suggest you inquire of the "lined" heater as an alternate.

EST. 1880

THE PATTERSON-KELLEY Company, Inc.

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Want to install automatic regulating valves and know they're right . . . now and in the future . . . ? For trouble-free operation that makes your good job better, specify and make sure you get KLIPFEL Automatic Regulating Valves, designed to give more consistent service, longer and with less maintenance.

Bulletin No. 146 describes the many KLIPFEL Valves used in heating, piping and air conditioning. Write Dept. C-4 for your free copy.

Float Valves, Reducing Valves, Tank Thermostats and Back Pressure Valves
Sold through wholesalers everywhere.

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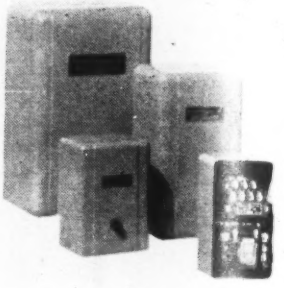
Magnetic Starters Feature One Piece Coil Enclosure



No. 4028—A new line of a-c magnetic starters is being produced by General Electric Co.'s control division, Schenectady 5, N. Y. Designed for starting and protecting motors up to 50 hp, the new full voltage units are furnished in all NEMA sizes from 0 through 3. The contactors can be furnished in NEMA sizes from 00 through 3.

An important feature of these starters is said to be the sturdy, one piece, plastic encased coil enclosure designed to protect the windings against dirt, moisture, or possible damage during installation. The clamp type coil terminals are embedded in this enclosure to prevent loosening. Self lubricated vertical slots in the enclosure are used to permit the magnet armature guides to move quietly and smoothly.

An arc shield of cold molded asbestos is used to prevent arc-over between contacts. The silicon steel magnet is said to be exceptionally durable and has a permanent air gap in a nonwearing surface to insure quick dropout. All steel parts are zinc plated.

Equipment Shorts

Minneapolis-Honeywell Regulator Co., Minneapolis, has acquired the assets of **H. Belfield Co.,** Philadelphia manufacturer of control valves. Howard L. Murray, former president of Belfield, is a vice president of Minneapolis-Honeywell and is in charge of the new acquisition, known as Belfield Valve Division. . . . The marine department of **Carrier Corp.,** Syracuse, has signed a contract with New York Shipbuilding Corp. for the complete air conditioning of three large, new 19 knot passenger-cargo liners now being built for American President Lines.

Allis-Chalmers Mfg. Co., Milwaukee, has purchased the last surplus property disposal center in Wisconsin, WAA warehouse 7. Located near South Milwaukee and comprising over 65 acres of land, the property will be used temporarily for warehousing and later will be converted to general manufacturing. . . . During the recent heating and ventilating exposition in Chicago, **Dravo Corp.,** Pittsburgh, sponsored its annual dinner for representatives of the heating section. . . . Expanded repair, maintenance, and warehouse facilities will be established in Salt Lake City by **General Electric Co.,** Schenectady. A new service shop and warehouse building is scheduled for construction this spring and will double the present capacity for handling motors, generators, transformers, control devices, and the assembly of special switchgear.

Marking its 40th anniversary, **Typhoon Air Conditioning Co., Inc.,** Brooklyn, recently held a banquet for members of the organization and its dealers and suppliers on the eastern seaboard. . . . Reductions of up to 10 percent in the retail prices of evaporative air coolers have been announced by **Utility Appliance Corp.,** Los Angeles. . . . **Armstrong Cork Co.,** Lancaster, Pa., has reduced the price on all types of corkboard 10 to 15 percent, the range

of productions depending on shipping zones. In reporting its 1948 operations, an album containing a brief report and a 7 in. phonograph record was sent to each employee. The record contains a spoken analysis by President H. W. Prentis, Jr. Last year company net profits on operations in this country and after taxes rose to an all time high of $11,567,524 as compared to $9,648,592 for 1947.

A recent three day general sales conference at **C. G. Hussey & Co.,** Pittsburgh, was attended by sales managers and representatives from all major sales offices and warehouses. The meeting marked the opening of an intensified program to be carried out this year. . . . Further expansion of the manufacturing facilities of **Fasco Industries, Inc.,** Rochester, N. Y., (formerly F. A. Smith Mfg. Co., Inc.) is taking place in the form of two new plant additions. . . . Plans for continuing studies, interrupted by World War II, in bending daylight with glass blocks have been announced by **Pittsburgh Corning Corp.** Plans are being completed for a new research "lighthouse."

A four story building, scheduled for completion next September, will be used by **Mine Safety Appliances Co.,** Pittsburgh, to house a modern research laboratory devoted to the development of safety equipment for mines, all industries, and public service organizations. According to the company, facilities will be made available to all industry, and activities will be coordinated with those of the U. S. Bureau of Mines, U. S. Public Health Service, etc. . . . More than 800 employees and members of their families attended the recent open house program at **E. F. Houghton & Co.,** Philadelphia.

The compressor and condenser unit division of **Mills Industries, Inc.,** Chicago, has been moved to the company's main plant in order to consolidate all manufacturing and to make use of improved facilities. . . . At the recent four day sales clinic of **Oster Mfg. Co.,** Cleveland, 1949 sales plans were presented and new and improved products were demonstrated. . . . The first phase of a long range service training program has been launched by **Frigidaire Div., General Motors Corp.,** Dayton, with a special five week training school initiated for key service representatives from 21 foreign countries.

L. O. Koven & Brother, Inc., Jersey City, N. J., has purchased the facilities and assets of **D. W. Whitehead Mfg. Co.,** Trenton, N. J. Operations will be combined to produce a new line of gas water heaters. . . . Last month, engineers and architects in the northern Ohio area attended an exhibition at **Temperature Equipment Corp.,** Cleveland, wholesale distributor. Heating, refrigeration, and air conditioning products of seven manufacturers were on display.

"Lucite" models of single and multi-floor buildings are being built to print dimensions with engraved scale grid floors by **Visual Planning Equipment Co., Inc.,** Oakmont, Pa. According to the company, models of any type of commercial or industrial building may be constructed with all columns, stairwells, elevator shafts, and other physical building characteristics exactly to specifications. Built to ¼ in. scale, models may be used to study building and planning problems and to indicate space available for various uses.

PAT. NO. 2, 297,928

A Complete Unit for a Complete job

You're always *sure* you're getting the very best in efficient, economical packaged air conditioning when you specify Governair—the original patented design!

This complete unit is easy to install—requires only simple electrical, water and duct connections. Built-in Evaporative Condenser keeps water usage down to a minimum. Governair engineering assures correct coordination and balance of all functions. Generously proportioned heat transfer surfaces provide maximum performance and economy.

Choose Governair completely packaged air conditioners and you'll *always* do your best!

ARCHITECTS • ENGINEERS • CONTRACTORS

Would you like to know how Air Conditioning jobs can be installed for from $100.00 to $400.00 per ton less?

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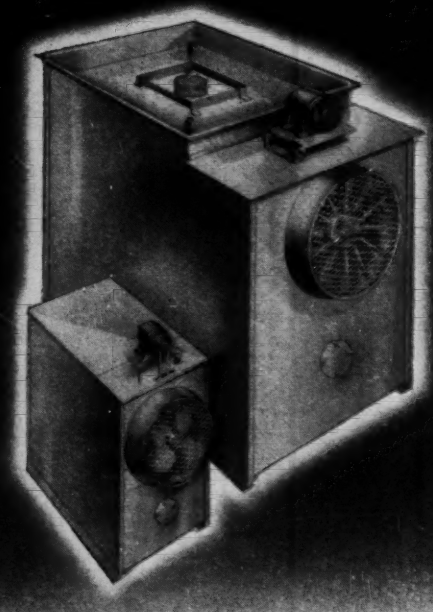
SPECIFY MARLEY *Aquatower*

For "PACKAGED" Cool Water



Do YOU need a cooling tower that

Requires no field erection?
Is completely assembled, ready to go?
Can be shipped immediately from stock?
Is primarily designed for air conditioning and refrigeration?
Is made from heavy steel with redwood filling?
Can be installed in limited space?
Operates indoors or outdoors?
Requires no skilled operator?
Can be readily repainted and serviced inside and out?
Ranges from 3 to 50 tons of refrigeration?
Will soon pay for itself in water savings?
Is backed by the Marley Guarantee?

If these specifications meet YOUR cooling tower needs, your best buy is the MARLEY AQUATOWER.

Designed in two styles and seven sizes, the compact MARLEY AQUATOWER packs more performance for those extra tough jobs.

Ask for Bulletin AQ-48A or let us send one of our factory trained application engineers to help you solve YOUR water cooling problems.

There is no cost or obligation.

MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC.

KANSAS CITY 15, KANSAS

WHO'S WHAT

The **Refrigerating Industry Safety Advisory Committee** recently elected its first officers. **W. H. Driscoll,** vice president, Carrier Corp., was elected chairman and represents the Air Conditioning and Refrigerating Machinery Association. **W. M. Timmerman,** commercial engineer, household refrigeration division, General Electric Co., is vice chairman and represents the National Electrical Manufacturers Association. The new treasurer is **C. M. Cordley,** president, Cordley & Hayes, who represents the Refrigeration Equipment Manufacturers Association on this committee. **Cyrus W. Miller** is executive secretary.

F. J. Van Poppelen is manager of manufacturing of **General Electric Co.'s** air conditioning department, Bloomfield, N. J. He recently succeeded **A. W. Wennerstrom** who, after more than 35 years with the company, is taking up new duties as manufacturing consultant on the department's manufacturing staff. In the firm's apparatus department, at Schenectady, N. Y., **S. W. Corbin** is now assistant manager of the industrial division and is continuing as manager of the resale industries division. . . . New officers elected at the recent 32nd annual meeting of the **National Association of Fan Manufacturers** are: president—**Edgar F. Wendt,** president, Buffalo Forge Co.; vice president—**R. A. Wasson,** vice president and general manager, Clarage Fan Co.; secretary-treasurer—**L. O. Monroe.**

Henry E. Perry, president of Commercial Solvents Corp., has been elected to the board of directors of **Carrier Corp.,** Syracuse, N. Y. He fills the vacancy created by the death of **Joseph H. McNabb,** former president of Bell and Howell Co. . . . The **New York Association of Consulting Engineers** has elected **William Eipel** president. A member of the structural engineering firm of Tuck & Eipel, he succeeds **Darl Hunt,** of Krey & Hunt, consulting engineers. Other officers are **John F. Hennessy,** Syska & Hennessy, vice president; **Harry Bond,** consulting engineer, treasurer; and **Donald Christie,** consulting engineer, secretary.

Frederick P. Combier and **Robert C. Cassidy** are now respectively sales manager and chief engineer for **Uskon Heating Panel Division, United States Rubber Co.,** New York. . . . The new industrial engineer for **Baker Refrigeration Corp.,** South Windham, Me., (formerly Baker Ice Machine Co., Inc.) is **Walter T. Martin** who was formerly with Universal Cooler Div., International Detrola Corp. He is in charge of all time, motion analysis, and methods engineering. . . . **Melvin C. Harris,** vice president in charge of production since 1946, **Allegheny Ludlum Steel Corp.,** Pittsburgh, has resigned. Pending the election of a successor, **C. B. Pollock** is in charge of production.

John F. Van Nort has been named manager of the western division of **Pyle-National Co.,** Chicago. He was formerly sales manager of Duff-Norton Mfg. Co., and in his new capacity will have headquarters in the company's San Francisco office. . . . **Avery Engineering Co.,** Cleveland, has oppointed **John S. McElwain** sales manager of

its merchandise department. He will supervise retail sales in the main office and branches in Columbus, Toledo, and Akron. . . . A Los Angeles branch office and warehouse has been established by **Ward Leonard Electric Co.**, Mt. Vernon, N. Y. **H. S. Eales** is district manager and E. R. **Slivinsky** is assisting.

Two new representatives of **Illinois Engineering Co.**, Chicago, are **Rent Engineering Co.**, 522 Chamber of Commerce Bldg., Denver, and **Philip J. Lamoureux**, 239 N. Pine Creek, Fairfield, Conn. . . . The new president, vice president, and secretary-treasurer of the **Industrial Unit Heater Association** are, respectively: **H. S. Wheller**, president, L. J. Wing Mfg. Co.; **L. D. Mandell**, vice president, C. A. Dunham Co.; and **L. O. Monroe**. . . . **Professor Thomas K. Sherwood**, dean of engineering at Massachusetts Institute of Technology, and **Dr. Bruce S. Old**, of the staff of **Arthur D. Little, Inc.**, Cambridge, Mass., have been elected to the company's board of directors. **R. C. Griffin** has retired as director and as assistant secretary under the firm's regular retirement plan.

Sam Tour & Co., Inc., New York engineers, metallurgists, and consultants, has reorganized the mechanical engineering department under the supervision of **John J. Meadows**. . . . **Carlos Morgan**, formerly assistant advertising manager for **Penn Electric Switch Co.**, Goshen, Ind., is now acting manager, succeeding **J. R. Netedu** who resigned to enter the advertising agency business. . . . **F. Joseph Butler**, 263 Cornell Dr., Crete, Ill., is now the Chicago territory representative for **Auer Register Co.**, Cleveland. . . . With headquarters in Houston, **J. L. Young, Jr.**, is manager of southwestern sales for **Wolverine Tube, Div. of Calumet and Hecla Consolidated Copper Co.**, Detroit. He is guiding sales in Texas, Arkansas, Louisiana, and Oklahoma and is supervising the operation of the company's Houston mill depot.

Minor Dow, 412 Curtis Bldg., Detroit 2, is the new Michigan representative for **Air-Maze Corp.**, Cleveland. He succeeds **Harry W. Lutz** who has been with the company for many years and has recently changed locations. . . . **A. B. Juud Supply Co.**, Houston, Tex., is a new distributor for **Tube Turns, Inc.**, Louisville, Ky. Mr. Juud was formerly president of Republic Supply Co., Houston, until he resigned last year to set up his own organization. . . . **W. A. Matheson** has resigned his position as executive vice president of **Eureka Williams Corp.**, Bloomington, Ill., but continues as a director of the firm. **E. H. Davison**, formerly manager of heating sales, is now general sales manager and has assumed the dealer-distributor sales supervisory duties of Mr. Matheson.

Recent distributor appointments for the apple storage units of **W. B. Connor Engineering Corp.**, New York, include: **McCune Co.**, Youngstown, for Ohio, western Pennsylvania, and northern West Virginia; **John Bacon Co.**, Gasport, N. Y., for western and northern New York; **Trobaugh Homestead**, West Frankfort, Ill., for southern Illinois and Indiana; and **Frost Insecticide Co.**, Arlington, Mass., for New England. . . . The new Detroit branch office manager of **Owens-Corning Fiberglas Corp.**, Toledo, is **Jan S. Irvine**. He has been associated with glass fiber products since 1931, was formerly manager of the firm's

Here's positive, controlled ventilation at all times, regardless of wind or weather! Snow, ice, wind or rain have no effect upon the certified performance ratings of the POWER-FLOW. Exhausts more air per brake horsepower than other ventilators. May be used with or without duct system.

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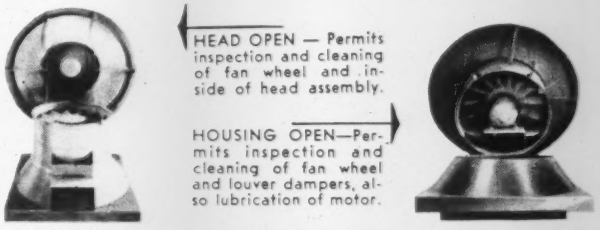
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air filter division, from 1940 to 1947 was in charge of the New York office, and more recently managed the transportation division.

Dr. Ralph L. Nuttall has been appointed to the staff of the **National Bureau of Standards** where he will do research on thermal conductivity of gases at elevated temperatures and pressures. He received his Ph.D. at Yale University where he was awarded the du Pont Fellowship in physical chemistry for 1947 and 1948. **Dr. John R. Pellam** has also been appointed to the bureau's staff and will do research in the cryogenics laboratory. He was formerly on the staff of the Research Laboratory of Electronics at Massachusetts Institute of Technology, and in 1947 was awarded the Presidential Certificate of Merit by the Secretary of the Navy for operations research conducted during the war.

Walter H. Holt, manager of the fan merchandise and standard apparatus dept., Buffalo Forge Co., has been elected president of the **Propeller Fan Manufacturers' Association. Lyman C. Reed**, president, Reed Unit-Fans, Inc., is serving as vice president and **L. O. Monroe** is secretary-treasurer. . . . As newly named assistant director of research for **Calgon, Inc.**, Pittsburgh, **Dr. Thomas H. Daugherty** is in immediate charge of research and development projects. **C. E. Kaufman** is assistant director of chemical research for **Hall Laboratories, Inc.**, an affiliated company. . . . **D. C. McCoy**, Frigidaire Div., General Motors Corp., is editor-in-chief of the 1950 refrigeration applications edition of the Refrigerating Data Book, published periodically by the **American Society of Refrigerating Engineers.** He served as associate editor of the data book in 1946, was chairman of the society's awards committee in 1947 and 1948, and is a member of the council.

Dr. G. V. Slottman, who joined **Air Reduction Co., Inc.**, New York, in 1934, has served as manager of the technical sales division, and last year was appointed technical assistant to the vice president in charge of sales, is now director of research and engineering. . . . **Acro Electric Co.**, Cleveland, has changed its name to **Acro Switch Co.** New directors are **W. F. Rockwell, W. F. Rockwell, Jr., F. P. Maxwell, Arthur Kroeger**, and **F. G. McCloskey**. . . . A group of Rockford, Ill., refrigeration and air conditioning contractors have formed a local association affiliated with the **National Association of Refrigeration Contractors.** Officers elected to serve for the first year include: president—**Lester L. Miller**, of the Miller Engineering Co.; vice president—**E. Reynolds**; secretary-treasurer—**James Best** of the Best Refrigeration Co.; directors—**Roy Shipman** and **R. C. McCarthy.**

At a recent annual sales meeting, **Cortland N. O'Day**, president, **Air Devices, Inc.**, New York, was presented with a diamond ring and testimonial scroll by members of the staff and sales representatives. . . . The new export department of **Howell Electric Motors Co.**, Howell, Mich., is maintaining offices in Detroit where all motor business outside of this country is transacted. **Harry D. Dodge** is in charge. . . . **American Thermal Industries, Inc.**, Detroit, has advanced **John J. Kramer** to the position of vice president. He has been general manager for the last two years.

You Benefit from

AEROFIN'S Unequaled Experience in Design and Manufacture of FIN-TYPE Heat Exchangers

For over 26 years, Aerofin — pioneer manufacturer of fin-type heat-transfer surface — has been accumulating an unequalled experience in the design and fabrication of heat exchangers. For the right design, materials and construction — for accuracy and efficiency — put your heat-transfer problems up to Aerofin.

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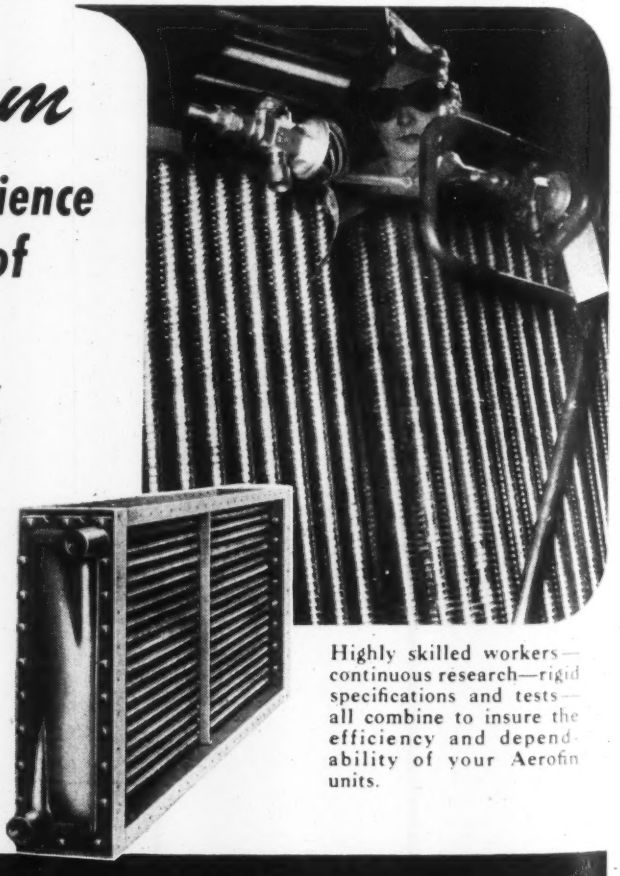

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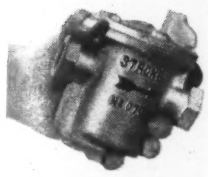
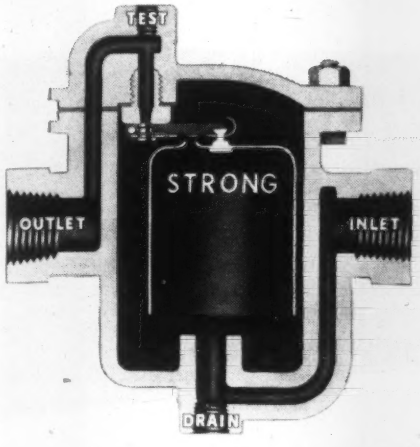


for small drainage jobs . . .

A NEW *SMALL* TRAP WITH *BIG* TRAP QUALITY FEATURES!



- Renewable seat—easily removed for servicing.
- Strong's patented, wear-resistant Anum-Metl† valve and seat—guaranteed leak-proof for one year. Scientifically designed Hi-Cap orifice gives greater capacity.
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- Horizontal inline connections—simplifies piping.
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Available for pressures from 0 to 150 p.s.i., the Strong* No. 070 fits all standard trap applications. Built especially for use on laundry, restaurant and hospital equipment and in industry wherever small drainage is a problem.

As with all Strong Semi-Steel Traps, the 070 is guaranteed against defects in material and workmanship for one year. Write today *for more complete information.*

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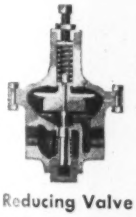
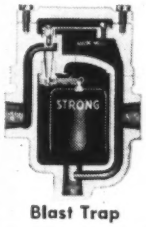
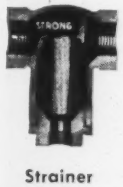

Reducing Valve

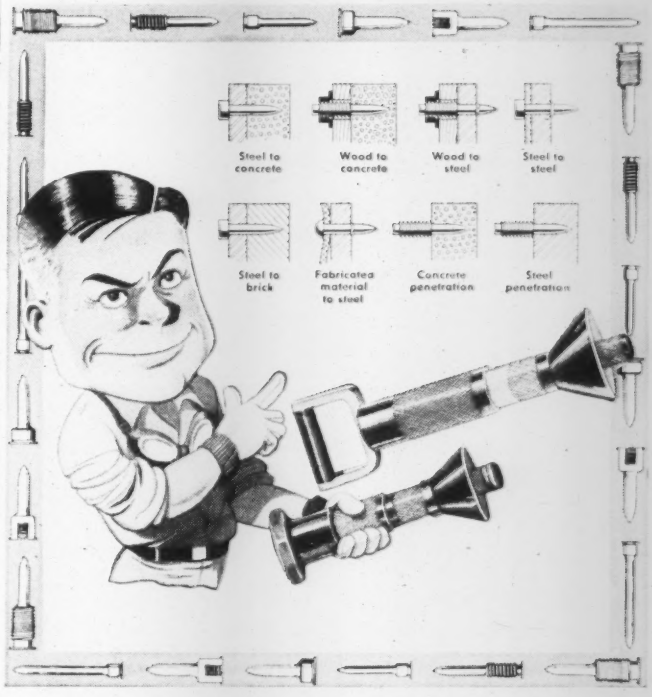


Blast Trap



Strainer

STRONG



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the multi-job man!

Fastening jobs like those illustrated are all in a day's work for JOE RAMSETTER. With his light, self-powered RAMSET TOOL and 63 sizes of pins and studs, he can set up to 50 fasteners per hour, to cut costs and finish the job faster.

No chipping, no drilling, no plugging. No electric or air lines. Prepare the RAMSET TOOL in 30 seconds. Then, place it against the work and RAM! The fastener is set instantly, tightly, easily. We teach any alert, careful workman to "RAMSET", in 30 minutes.

For fastenings in steel, concrete and other hard-to-work materials, RAMSET pays big dividends in time and money. Use the coupon for complete information. *Stemco Corporation, Cleveland 16 (Rocky River), Ohio.*

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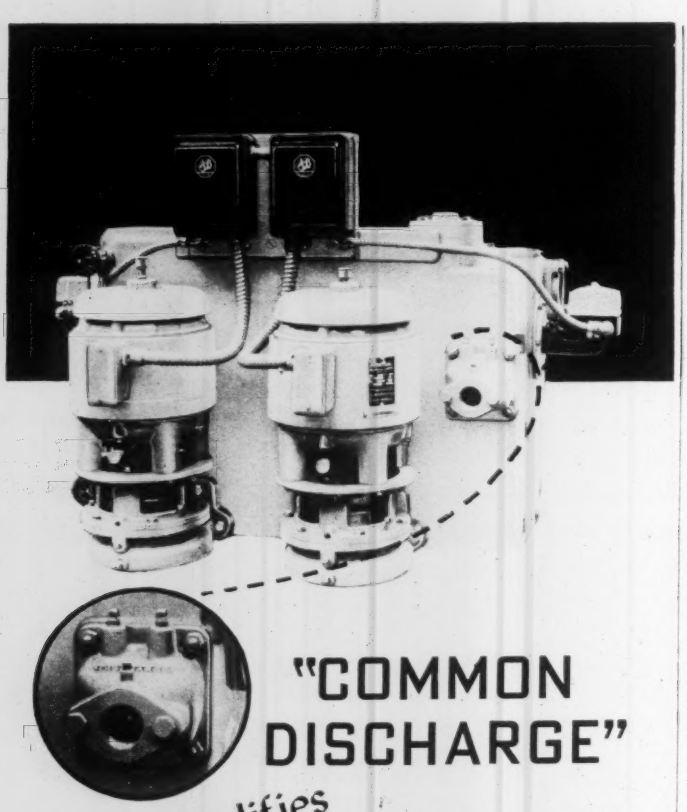

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Simplifies
PIPING LAYOUT

● Common Discharge is an exclusive feature of the DOMESTIC AMES duplex condensate return pumps. Many additional features are included to achieve low cost operation and high efficiency in returning condensate to the boiler. Sold with a guarantee of performance.

"If it's a job for a pump - it's a job for Domestic"

*Single or Duplex Units Available

"DOMESTIC"
ENGINE & PUMP COMPANY
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McQuay, Inc., Minneapolis, has re-appointed **Halberg Co.**, 3423 Farragut Rd., Brooklyn 10, as its heating and air conditioning representative in Brooklyn, Long Island, and Staten Island. Dick Halberg represented the company from 1941 through 1945. Previous to that he was, for 10 years, sales engineer in the New York area for The Trane Co. and more recently has been a sales representative for a number of manufacturers . . . **W. B. Osgood** has become a partner in **Dunbar Engineering Co.**, New York, representing **Edward Valves, Inc.**, East Chicago, Ind. Since 1938 he has been sales representative, assistant manager of sales, and finally district representative for National Tube Co.

As manager of product divisions, **W. C. Schade** is directing and coordinating the activities of various divisions of Olin Industries, Inc., East Alton, Ill. He is also supervising advertising and sales promotion, public relations, market research and statistics, and government contracts relating to procurement. . . . The new sales manager for **Askania Regulator Co.**, Chicago, is **Wilson W. Wheeler** who joined the firm in 1941 and who has been head of the sales engineering department since 1945. . . . **Glenn D. Culbert**, 1006 du Pont Circle Bldg., Washington, is handling the District of Columbia, bordering counties of Maryland, and the northern portion of Virginia as sales representative for **American District Steam Co.**, North Tonawanda, N. Y.

Timken Silent Automatic Div., Timken-Detroit Axle Co., Jackson, Mich., has appointed seven new district sales managers and **T. O. Lawler** as regional manager for Ohio, West Virginia, Indiana, Kentucky, and Tennessee. New district managers and their territories are: **John A. Pratt**, Maine; **John J. Morro**, western Connecticut and western Massachusetts; **Hanford Gruher**, New Jersey; **E. M. Cahill**, Illinois; **F. H. Huber**, Iowa, Missouri, and Nebraska; **Wilbur W. Gregg**, Michigan; **Robert S. Daniels**, Kentucky, Ohio, and West Virginia.

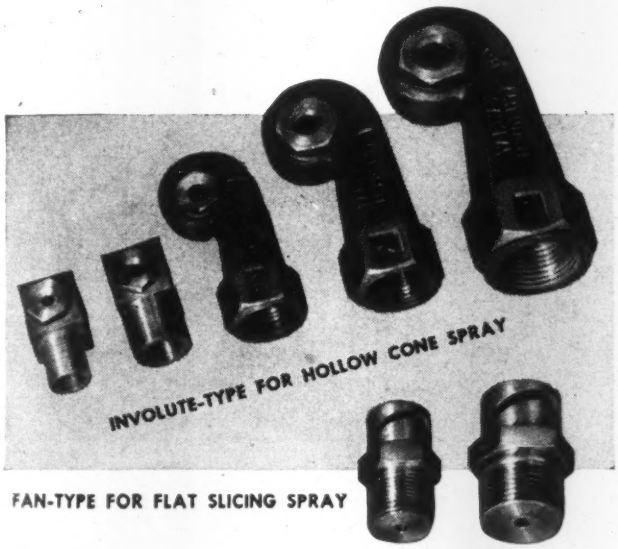
Metal & Controls Corp. comprised of the **Spencer Thermostat Division** and the **General Plate Division**, Attleboro, Mass., has elected **Rathbun Willard** chairman of the board and general manager, succeeding the late **Russell Grinnell. Victor D. Davignon**, for the past several years vice president in charge of production, is now president; and **Victor G. Vaughan**, a vice president of the corporation and general manager of Spencer Thermostat, is executive vice president. **George A. Matteson, Jr.**, has been elected to the board of directors.

R. V. Wellington, with headquarters in New Orleans, is representing **Radiator Specialty Co.**, Charlotte, N. C., in Louisiana, Mississippi, and Alabama. **M. W. Shumaker** is covering southern California and Arizona. . . . A director of the company since its organization and, until recently, assistant to the president, **Bradley C. Higgins** is now vice president and purchasing agent of **Livingstone Engineering Co.**, Worcester, Mass. . . . As the new treasurer of **L. O. Koven & Brother, Inc.**, Jersey City, N. J., **H. W. MacIntosh** will continue in charge of purchasing and stores control.

for • SPRAYING
• WASHING
• RINSING
• COOLING
• AIR CONDITIONING

YARWAY

SPRAY NOZZLES



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Get the most out of your Spraying Equipment with minimum power . . . with efficient spraying.

Use Yarway Nozzles. No internal vanes or other restrictions to clog or hinder flow. Two types—Yarway Involute-type producing a fine hollow spray with minimum energy loss, and Yarway Fan-type producing a flat fan-shaped spray with time-saving slicing action for cleaning.

Wide range of standard sizes and capacities. Cast or machined from solid bar stock.

Thousands in use. Write for Bulletin N-616.

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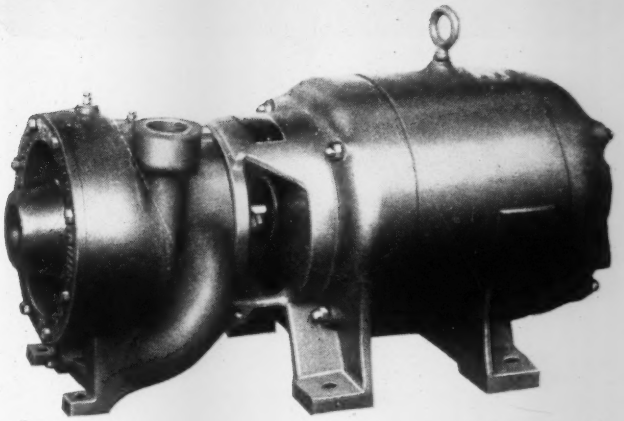
for DEPENDABLE CIRCULATION
of BRINE AND CHILLED WATER!



Type GG Two Stage Unipump with 15 H.P. motor.

OPERATES EFFICIENTLY IN ANY POSITION

WEINMAN Centrifugal UNIPUMPS

CAPACITIES 10 TO 1000 G.P.M.

UNIPUMPS are engineered by WEINMAN CENTRIFUGAL SPECIALISTS to meet the need for a highly efficient, quiet and leakless BRINE AND CHILLED WATER CIRCULATOR . . . at a reasonable price!

They will operate efficiently regardless of the angle of installation on floor or wall . . . require minimum space . . . and are easy to install.

Built in sizes to provide capacities of 10 GPM to 1000 GPM . . . heads to 500 feet . . . and motor ratings from ½ hp to 30 hp.

WEINMAN CENTRIFUGAL SPECIALISTS are at your service . . . To Give Service . . . got a problem? . . . phone, wire or write.

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NEW BOOKS & REPORTS

Handbook on Corrosion Represents a Tough Job Well Done

For many years engineers have been growing apprehensive of the "tax" being imposed upon industry by corrosion. Reflecting this is the ever increasing number of technical papers that are published on the subject.

Only within comparatively recent years, however, have the specialists in this field been making a concerted effort to put their information to work on a broad scale. To the Electrochemical Society belongs most of the credit for organizing these endeavors.

In 1942 this society organized within itself a corrosion division which was immediately charged with compiling a "condensed summary" of authoritative information pertaining to virtually all ramifications of the subject. To this end an editorial advisory board was recruited, from the most distinguished engineers and scientists active in the field, and virtually all of the industrial specialists were invited to submit digests of the information they considered most authoritative. After about six years effort upon the part of over 100 collaborators, the Corrosion Handbook was recently published. As such it comprises an impressive volume. Since it contains a considerable amount of hitherto unpublished data, it unquestionably represents the most comprehensive compilation that has yet been offered.

To the corrosion engineer this book is indispensable. Emphasis is on scientific data and industrial experience in an effort to place at his disposal the basis for sound interpretations. While, of necessity, some theories are presented, quantitative data have been stressed.

Those not experienced in corrosion engineering should not expect to find therein "prefabricated" solutions for specific corrosion problems. Because the book attempts to cover an extraordinary broad and complex field only the material mandatory to the *development* of remedial measures could be offered. Any attempt to describe the techniques of assembling such material to fit specific problems would have made the book prohibitively large.

It should not be inferred that only an experienced technologist will find this book helpful. On the contrary those who only rarely are compelled to consider corrosion problems will be benefited if they do nothing more than familiarize themselves with the definitions and terms given in the glossary.

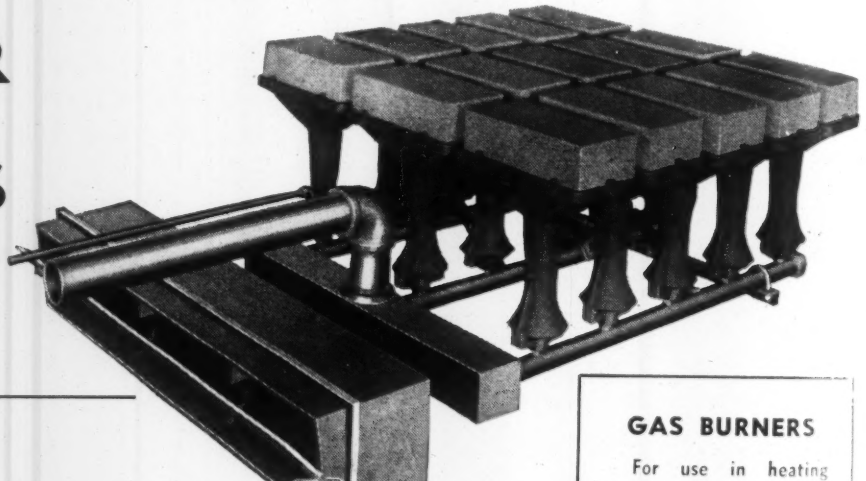
In the heating and ventilating field the discussions offered in Section III on special topics in corrosion, especially those dealing with hot and cold water systems, deactivation and deaeration of water, steam condensate lines, condensers, and lubricants, will probably prove most useful. Section VII on corrosion protection contains much usable material on protective coatings.

In general, the text represents a tough job well done and for this accomplishment the sponsoring society is entitled to considerably more than a curtsy.

Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City, and edited by Herbert H. Uhlig, associate professor of metallurgy in charge of the corrosion laboratory, Massachusetts Institute of Technology.

WEBSTER
Series F600
GAS BURNERS

50,000 to 10,000,000 Btu.



The Series F600 Burner operates on straight natural gas and mixed gas to 800 Btu. Gives perfect horizontal distribution. Fully automatic controls—that operate properly—can be easily applied.

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GAS BURNERS

For use in heating boilers, power boilers, —in any metal firebox or sectional boiler.

Adaptable to any firebox shape or size.

Handles various gas pressures and effects low draft loss.

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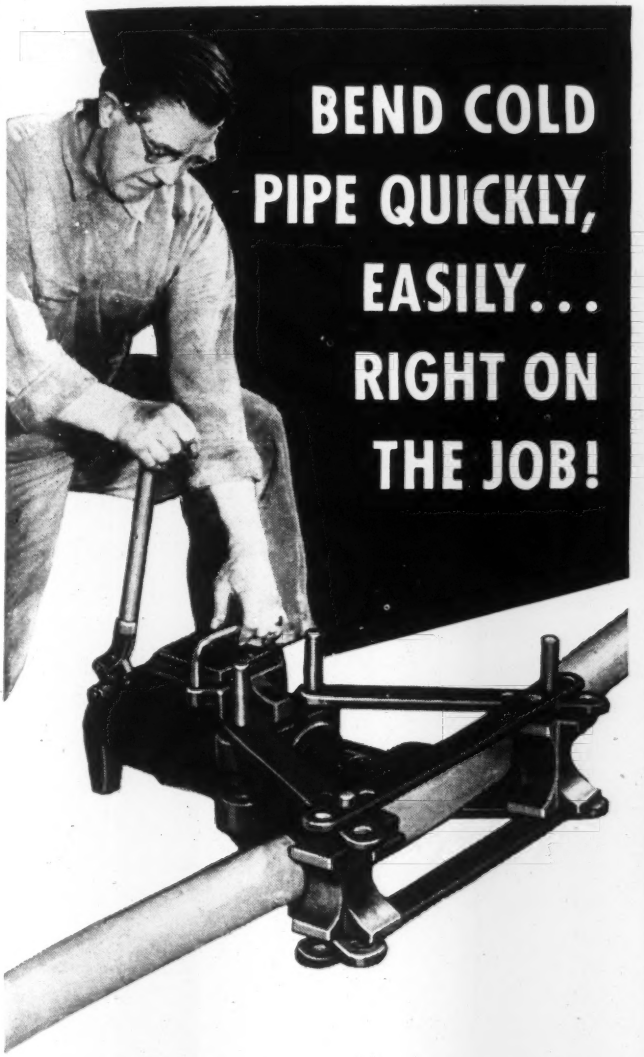
TULSA **OKLAHOMA**



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Yes, make pipe bends "right on the job" . . . exactly where and when you need them! And do the job swiftly, accurately with a GREENLEE Hydraulic Pipe Bender.

Bends pipe up to 4½". Simple to operate, easy to carry, set up and shift from job to job. With a GREENLEE *one man* makes smooth, precise, uniform bends in but a few minutes. Speeds your piping installations, cuts costs on labor and materials. In timesavings alone, the GREENLEE pays for itself quickly.

Ideal for radiant heating jobs, too. For complete details write for free Bender Booklet E-201. Greenlee Tool Co., Division of Greenlee Bros. & Co., 2344 Twelfth Street, Rockford, Illinois.

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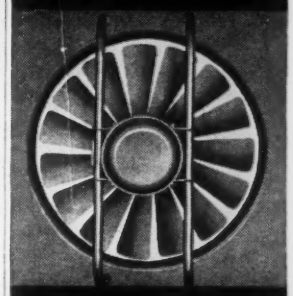
FOR FAST, QUIET AIR MOVEMENT INSTALL Peerless Electric PROPELLER FANS



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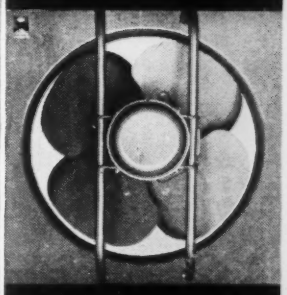

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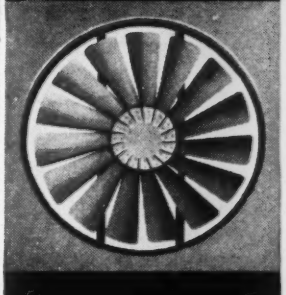

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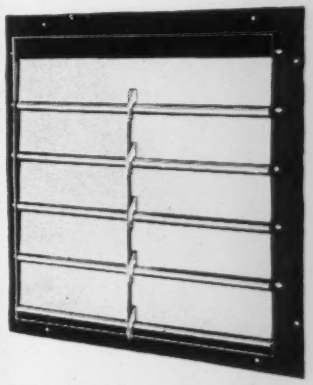
NO matter what your need for quiet, variable speed, attractively designed fans, you'll find the answer in a Peerless Electric design.

A combination of specially engineered capacitor motors and perfectly balanced extra wide blades produces extremely quiet operation. Motors are totally enclosed and permit installation in either a vertical or horizontal position.

These fans are supplied in single-speed, two-speed or three-speed operation and finished in gray. Recommended for stores, restaurants, hotels, offices and similar installations where quietness of operation and attractive appearance are prime requisites. Write for descriptive folders.



Automatic Louvers

Peerless Electric automatic louvers are designed especially for use with propeller fans. When the fan starts, the air stream instantly opens the louvers, which close by gravity when the fan stops. Completely weather-stripped around the inner edge of the frame. Built of high grade aluminum. Sizes from 10 to 48 inches.

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Announcing

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Bulator

the first practicable combination of an ornamental grille and a deflecting vane grille.

Recently developed by Hendrick, and tested by Professor G. L. Tuve of the Case Institute of Technology, Cleveland, the Hendrick BULATOR* meets every requirement of architect and engineer for a grille of attractive appearance with proper air throw and spread.

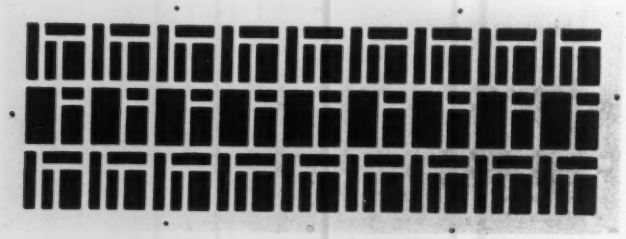
Mounted just behind the ornamental grille, the deflecting grille is not noticeable, but gives the air throw and spread that may be specified by the engineer. The tests made at the Case Institute showed that the presence of the ornamental grille made "very little difference on either the air stream pattern or the throw."

The vanes of the deflecting grille are adjustable so that the air flow can be deflected to right or left, up or down, or in a combination of directions.

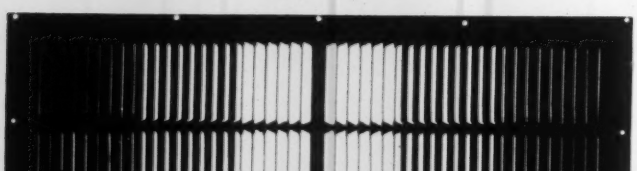
A wide variety of Hendrick ornamental grilles, with ample open area, are available, so that the BULATOR enables the architect to combine with the air-conditioning system of a building ornamental grilles which harmonize with the decorative scheme, without appreciably affecting the air throw.

* *Beauty + Ventilator.*

Write for full information



Photograph taken with deflecting vanes less than an inch behind grille, shows that vanes are not noticeable.



Vertical deflecting vanes, showing how the vanes may be set to produce any desired air stream pattern.

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the handbook contains 1188 + xxxiii pp, 6 in. x 9 in., is clothbound, and is priced at $12.00.—Reviewed by Leo F. Collins, chemical engineer, central heating dept., The Detroit Edison Co., chairman of the American Society of Heating and Ventilating Engineers' technical advisory committee on corrosion, and member of HPAC's board of consulting and contributing editors.

Psychrometric Chart in Circular Slide Rule Form

Based on the General Electric Co. psychrometric chart (copyrighted 1942) a 9 in. cardboard, circular slide rule has been developed for use in the solution of air conditioning problems.

Covering the dry bulb temperature range of 20 to 120 F, it may be used to determine the relationships between dry bulb and wet bulb temperature, dew point, percent relative humidity, and specific volume in cu ft per lb of dry air. Fixed scales are included for finding the relationships between Fahrenheit and Centigrade degrees; wet bulb temperature and total heat in Btu per lb of dry air (enthalpy at saturation above 0 F); and dew point, moisture content in gr per lb of dry air, and vapor pressure in lb per sq in. Light pencil marks or lines may be made on the reverse side which contains a reproduction of the conventional psychrometric chart.

These slide rules may be obtained for $2.00 from Schwerin Air Conditioning Corp., 570 Lexington Ave., New York 22.

Proposes Revisions to Mineral Wool Standard

The inclusion of requirements for loose, granulated, and felted forms of mineral wool, together with revised illustrations showing methods of fastening and application to various heated surfaces, has been proposed for Commercial Standard CS117-44 (TS-4757) which covers mineral wool blankets, blocks, insulating cement, and pipe insulation for heated industrial equipment.

Proposed by the Industrial Mineral Wool Institute and approved by the standing committee, copies have been distributed to manufacturers and other interested groups for consideration and approval. A limited number of mimeographed copies are available from the Commodity Standards Division, National Bureau of Standards, Washington 25, D.C.

Tabulates Manometer Conversion Factors

In an effort to facilitate and standardize the use of manometers and U tubes as direct pressure indicating instruments or in the calibration of pressure recorders and controllers, the Instrument Society of America has published Recommended Practice RP2.1—Manometer Tables.

Abbreviations and fundamental conversion factors commonly used in manometry are presented and recommended definitions of pressure are given in terms of a column of mercury and water.

The 32 page, 8½ x 11 in. leaflet is punched for insertion in a three ring binder and may be obtained from ISA headquarters, 1117 Wolfendale St., Pittsburgh 12. The price to nonmembers is $2.00.

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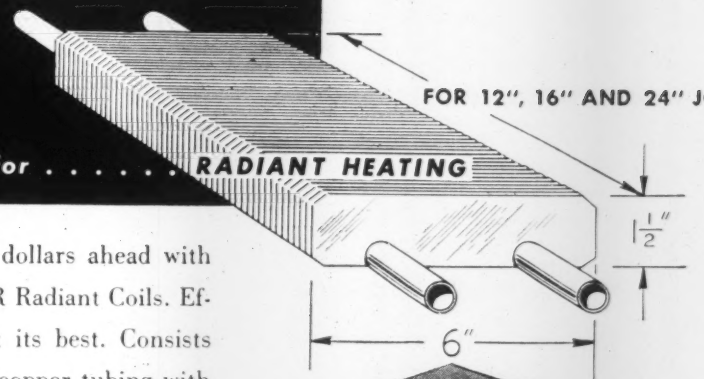
the economy unit for . . . . . RADIANT HEATING



Put yourself days and dollars ahead with new, modern, KRITZER Radiant Coils. Effective heat transfer at its best. Consists simply of 5/8" two way copper tubing with mechanically bonded aluminum radiating fins. Two men in a few hours install the entire heating arrangement up to pump manifold—and *do it* just as soon as the framing is up. Once you've put the unit in, that's all—it's permanent—no extras—no callbacks. KRITZER Radiant Heat is an installation *you can guarantee.*

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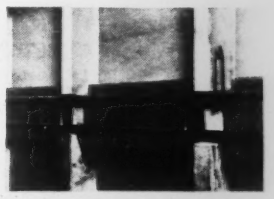

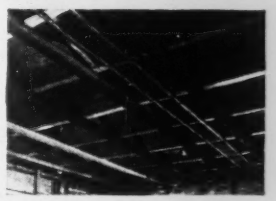

Coil sections are fabricated to fit spacings of 12", 16" or 24" between joists and studs. If it is hung below joists, 2" furring strips are applied for ceiling suspension. Coil sections are connected with solder rings and soldered together—hung from specially provided hangers.

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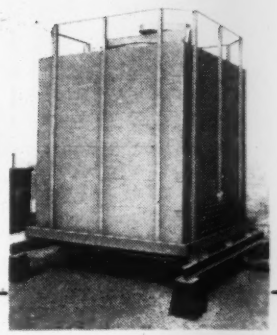
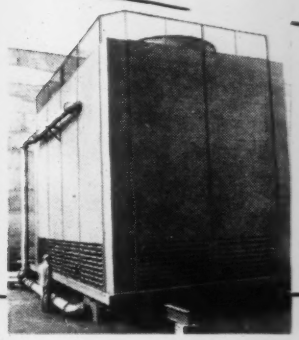
A size and type for every water-cooling requirement.

Binks Type 2K-S spray filled induced draft cooling towers. Binks 2K-S series cooling towers are ideal for a wide range of commercial water-cooling applications within 150-645 GPM capacity, where use of nozzles is preferred to interior decking for water distribution and break-up. Simple in construction, these units are easy to assemble and erect in the field without skilled help or factory supervision. In 20 standard sizes.

Binks Type 2K-W wood filled steel cased induced draft cooling towers. Series 2K-W cooling towers are widely used for all sorts of industrial applications where high wet bulb design conditions must be satisfied. These towers are all-steel construction, with internal decking and drift eliminators of redwood. Filming action of deck surfaces increases length of time that water is exposed to air, thus creating greater cooling efficiency. Available in 20 standard sizes.

Binks type "K" heavy duty induced draft cooling towers. Widely used for large air conditioning, refrigeration and related installations where abundant circulating water is needed. In "spray filled" or "deck filled" types, depending on service, cooling range, design wet bulb and approach desired. Readily painted to harmonize with most buildings. Tower framing and casing are all-steel, prefabricated for easy assembly.





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Contains full information on capacities, sizes, weights, etc., together with tower numbers.

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39. Heavy Duty Cooling Towers

Please state how tower will be used, also capacity required.

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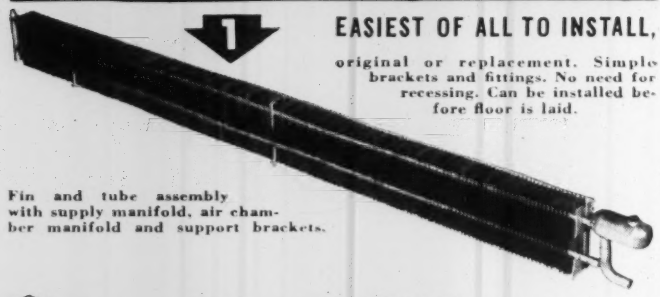
1 EASIEST OF ALL TO INSTALL, original or replacement. Simple brackets and fittings. No need for recessing. Can be installed before floor is laid.

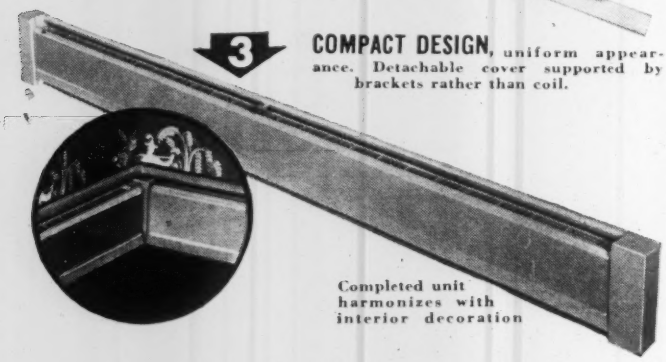


Fin and tube assembly with supply manifold, air chamber manifold and support brackets.

2 MORE EFFICIENT, high heat transfer at low water temperatures due to greater BTU capacity per lineal foot.

Assembly showing deflector, damper and end cap — corner piece.

3 COMPACT DESIGN, uniform appearance. Detachable cover supported by brackets rather than coil.



Completed unit harmonizes with interior decoration

- **Heating capacity: 600 BTU per hour per lineal foot with 170° forced water.**
- **Copper tubing and manifolds with aluminum fins, heavy gauge sheet steel cover, damper, deflector and end caps.**
- **Fin and tube assemblies available in foot lengths, from 2 to 9 feet.**

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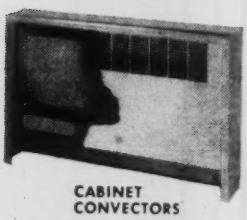
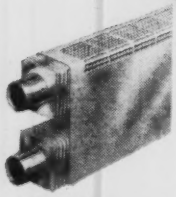
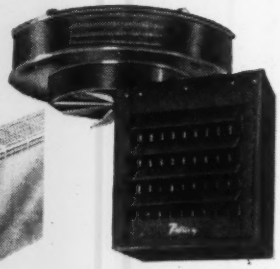


CABINET CONVECTORS



CONVECTOR RADIATORS



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Convention Proceedings Deal with Catholic Building Problems

The First National Catholic Building Convention and Exposition, held last June, was sponsored by the Business and Industry Foundation of St. Joseph's College for the purpose of providing information on problems in connection with Catholic building programs.

The proceedings of this meeting carry complete addresses by various technical and church authorities, as well as answers to questions posed by delegates. Among the subjects covered are building objectives, community planning, layout of the parochial or institutional group, architectural design, heating and air conditioning, planning the institutional kitchen, and building materials. Also included are specific panel sessions on recreational buildings, churches, school equipment, and remodeling.

Printed copies of the proceedings, 305 pp. and paper covered, are available for $3.00 from the Rev. J. A. Otte, treasurer, St. Joseph's College, Collegeville, Ind.

Other Books and Reports Received

American Standard Plumbing Code, ASA-A40.7-1949, published by the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, and priced at $2.50—Sponsored by the American Public Health Association and the ASME under procedures of the American Standards Association, the 87 page code is the work of 30 national organizations and government bodies. It covers minimum safety and health requirements for design, installation, inspection, and performance of plumbing equipment and systems, including water supply, distribution, drainage, and venting systems. It does not include dimensional standards, material specifications or marine installations. The purpose is to "present a coordinated set of rules which will serve as a guide to state and municipal authorities . . . and which may be adopted by them in whole or in part".

Bibliography on X-Ray Stress Analysis, by Herbert R. Isenburger, published by St. John X-Ray Laboratory, Califon, N. J., $3.00 per copy, 17 pp. 8½ x 11 in., looseleaf form.—Lists 240 references which deal with virtually all phases of the subject. Also included is a subject index.

The Nitrogen Meter, by John C. Lilly and Thomas F. Anderson, published by the Office of Technical Services, Department of Commerce—Gives details on a device for continuously recording the concentration of nitrogen in gas mixtures by photoelectric means. Developed under government contract by the University of Pennsylvania for the evaluation of oxygen supply systems used in high altitude flying, the meter is expected to have other applications. For example, it is said to be useful in lung function studies in medical research. Identified as PB95822, photostat copies at $5.00 ($2.25 in microfilm) are available from the Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D.C.

Coding of Thermocouple Wire and Extension Wire, RP1.1—A tentative standard published by the Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12, gives recommended symbols for thermocouple combinations and extension wire. Four pages, 8½ x 11 in., the price is $1.00 for nonmembers.

POSITIVE LIQUID LEVEL CONTROL WITH PNEUMATIC PILOT OPERATION

External cage, flange or spindle type float unit may be used.

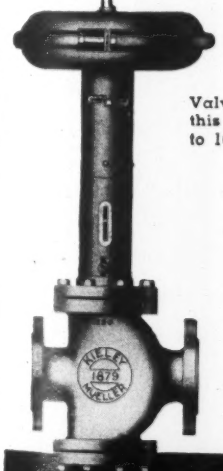
FOR DIFFICULT LIQUID LEVEL CONTROL APPLICATIONS

The motion of the float is transmitted directly to the pilot, which in turn applies the proper pressure from an auxiliary air or gas line to the Kontrol Motor Diaphragm Valve, thereby positioning the inner valve and controlling the liquid level.

Air or non-corrosive gas at 20-25 p.s.i. is used to operate pilot which may be installed as much as 100 feet away from the Kontrol Motor Diaphragm Valve.

Adjustment of throttling range can be made while unit is in operation and full valve travel with float movement from 1" to 8" can be obtained.

A wide combination of float units and valve sizes may be used. Request Bulletin 1000 from Kieley & Mueller, North Bergen, New Jersey.



Valve sizes for this service up to 16".

The Kieley & Mueller policy of continued pioneering has helped the K&M reputation grow constantly throughout the past 69 years. Look to K&M for: BACK PRESSURE REDUCING VALVES • PRESSURE REDUCING VALVES • STRAINERS • ATMOSPHERIC RELIEF VALVES • STOP AND CHECK VALVES • STEAM SEPARATORS • GREASE EXTRACTORS.

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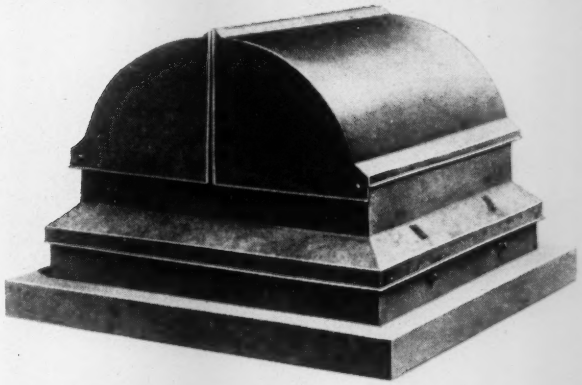
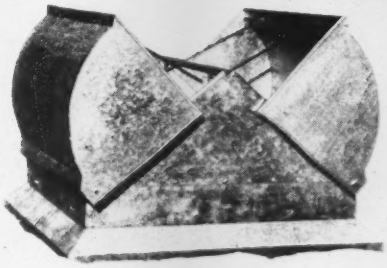
Factories use Ject-O-Valve for quick removal of heat and fumes





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In operation, the air stream from a scientifically designed propeller fan opens top sections, holds them open while fan is operating. Top closes automatically — weather tight — when ventilator is not in use. Ject-O-Valve is made in five sizes, 28 different capacities. Various operations can be served separately with appropriate Ject-O-Valves for each. Write for Ject-O-Valve folder and prices.

Swartwout makes powered and gravity roof ventilators that fill every industrial ventilation need.

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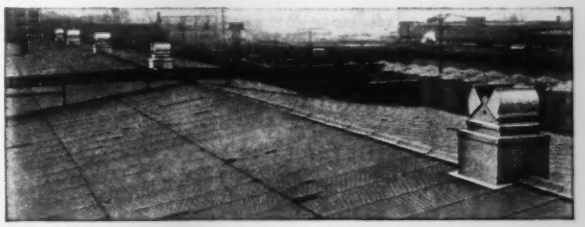

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MEETINGS & CONVENTIONS

NACE Conference and Exhibition—The fifth annual affair of the National Association of Corrosion Engineers, 905 Southern Standard Bldg., Houston, Tex., will be held at the Netherland-Plaza hotel, Cincinnati, April 11 to 14. Some 42 technical papers will be given at 11 symposia on corrosion principles, chemical, electrical and communication industries, cathodic protection, protective coatings, salt water corrosion, and the gas, transportation, and general industries. Among the many technical papers scheduled are: Why Metals Corrode, by H. H. Uhlig, Massachusetts Institute of Technology; Engineering Aspects of Cathodic Protection as Applied to Pipe Lines, by E. P. Doremus, G. L. Doremus, and M. E. Parker, Cathodic Proctection Service, Houston; Erosion-Corrosion of Metals and Alloys, by W. A. Luce and M. G. Fontana, Ohio State University; Porcelain Enamel as a Corrosion Resistant Coating, by G. H. McIntyre, Ferro Enamel Corp., Cleveland; Corrosion of Steel Pipe by Chlorinated Sea Water at Various Velocities, by V. B. Volkening, Dow Chemical Co., Freeport, Tex.; and Cathodic Protection of Gas Distribution Systems, by A. W. Peabody and C. L. Woody, Ebasco Services, Inc., New York.

The 11th Midwest Power Conference, April 18 to 20, Sherman hotel, Chicago—Sponsored by Illinois Institute of Technology, 3300 S. Federal St., Chicago 16. Conference secretary is Dr. E. R. Whitehead, director, electrical engineering dept., Illinois Tech.

Among the many subjects programmed, technical sessions will deal with control characteristics of industrial processes, maintenance problems of small plants, heating and air conditioning, the heat pump, and feedwater treatment. Technical papers scheduled for these sessions include:

Significance of the Process in Problems of Thermal and Flow Regulation, by Albert F. Sperry, president, Panellit, Inc.

Significance of Controller Dynamics in Electro-Mechanical Systems, by Richard W. Jones, associate professor of electrical engineering, Northwestern Technological Institute.

Preventive Maintenance Program for Small Plants, by Leland J. Mamer, chief engineer, Evanston hospital.

Maintenance of Package Boilers, by F. W. Hainer, vice president, Cleaver-Brooks Co.

Room Air Distribution in Year 'Round Air Conditioning, by G. L. Tuve, head, department of mechanical engineering, Case Institute of Technology, and immediate past president of the American Society of Heating and Ventilating Engineers.

Transmission of Heat by a Fluid Carrier, by Samuel R. Lewis, consulting engineer.

Some Aspects of the Soil Problem in Connection with Heat Pump Buried Coil Design, by Donald M. Vestal, Jr., project supervisor, reverse cycle heating project, Texas A. & M. Research Foundation.

Controlling the Heat Pump, by F. R. Ellenberger, remote equipment engineering div., air conditioning dept., General Electric Co.

Problems Encountered in the Treatment of Cooling Tower Water for the Prevention of Incrustation and Corrosion, by E. C. Hosbach, power engineer, The Texas Co.

Problems in the Treatment of Cooling Water in Industrial Plants, by L. D. Betz, general manager, and John J. Maguire, technical director, W. H. & L. D. Betz, chemical engineers.

Portland Fuels Conference, April 22, Multnomah hotel, Portland, Ore.—The present and long range price and supply situation of industrial fuels is the subject of this conference sponsored by Raw Materials Survey, Inc., and the Oregon section of the American Institute of Mining and Metallurgical Engineers. Speakers will cover coal, wood, gas, oil, and electricity.

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Made up of articles and data on this subject that appeared originally in "Heating, Piping & Air Conditioning," this booklet is the most comprehensive and authoritative collection of information on radiant heating and cooling yet assembled. It tells exactly what radiant heating is, where it can be used, and how to design complete systems. In addition, it contains fully detailed descriptions of numerous panel heating and cooling installations.

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BUT capable of repetitive, extra heavy duty as an automatic shut-off valve for:
Gas
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Light Oils
Steam (up to 175 psi)
and many other liquids and gases

What do we mean by "repetitive, extra heavy duty"?

We mean that you can cycle this valve at rates up to 400 closings per minute for millions of operations without need for repairs. We mean it can handle pressures up to 250 psi on air and non-corrosive gases . . . up to 175 psi on water, steam, refrigerants . . . on light oils up to 150 psi. We mean that the solenoid coils are Class A insulated for temperatures up to 212° F and high temperature insulated for temperatures up to 450° F. We mean that valve discs close in direction of flow and are of the ASCO Self-aligning form to insure tight-seating under all conditions. One pipe size only—3/8 inch; three port areas—1/8, 5/32 and 1/4 inch.

Yes, our Bulletin 8265 Shut-off Solenoid Valve will provide a lot of repetitive service. It's efficient and durable. In asking for Valve Section 6-V, which gives full details of this valve, tell us about your problem.

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New Jersey Society of Professional Engineers, 86 E. State St., Trenton 8, N. J.—25th annual convention, to be held April 29 and 30, Essex House, Newark, N. J. A major feature will be industrial, engineering, and commercial exhibits.

American Foundrymen's Society, 222 W. Adams St., Chicago—1949 annual meeting, May 2 to 5, St. Louis, Mo.

Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12—The fourth annual spring meeting will be held at the Royal York hotel, Toronto, Canada, May 12 and 13. The tentative program indicates four technical sessions and a dinner.

Technical papers and panel discussions will cover such subjects as unit start-up problems, chemical process instrumentation, instrument department organization, and applications in the pulp and paper in industry.

The 1949 conference and exhibit are scheduled for September 12 to 16 in St. Louis, and the 1950 convention and exhibit will be held in Buffalo, September 11 to 15.

Oil-Heat Institute of America, 6 E. 39th St., New York City—1949 national convention and National Oil-Heat Exposition, May 16 to 20, Boston. Convention headquarters will be the Statler Hotel and the exposition will be in Mechanics Hall.

Speakers will be heard on merchandising, engineering, construction, and industry problems. May 20 has been designated "engineering day."

Those planning to attend are urged to make hotel reservations at the earliest possible moment by writing to the Boston Chamber of Commerce, housing bureau, 80 Federal St., Boston 10.

National District Heating Association, 827 N. Euclid Ave., Pittsburgh 6—40th annual meeting, New Ocean House, Swampscott, Mass., May 24 to 27.

Food Distribution Exposition—Sponsored by the United States Wholesale Grocers Association, the first national show to be devoted to all phases of the food distribution field will be held at the St. Louis Auditorium, May 30 to June 1. Wholesalers' warehouse and office operation, store modernization, and merchandising methods will feature the business sessions. Registration cards for admission may be obtained from Clapp and Poliak, Inc., 350 Fifth Ave., New York 1, show manager.

1949 Canadian International Trade Fair, May 30 to June 10, in the Exhibition Grounds, Toronto—An integral part of the long range planning for the development of Canada's foreign trade, the fair will consist of a large number of exhibits covering 21 trade classifications. In the building materials, heating, and plumbing section air conditioning equipment and accessories will also be on display. Additional information may be obtained from R. M. Williams, CITF headquarters, Exhibition Grounds, Toronto.

Fourth Annual Construction Industries Exposition and Home Show—June 2 to 12, Pan-Pacific Auditorium, Los Angeles. Designed to show commercial, residential, and

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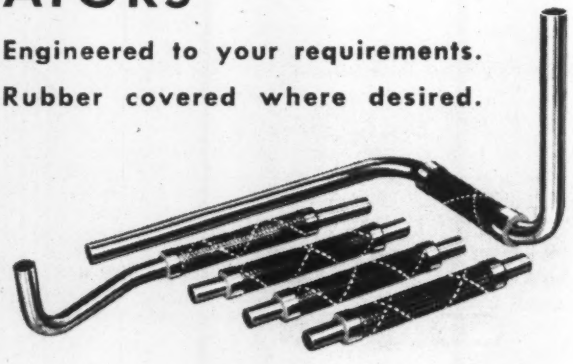

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How to lick a phantom

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Consider EVERY factor when you buy insulation—and you'll buy NOVOID

Check list of insulation properties

	Novoid Cork Insulation	Many Other Insulations
First cost	moderate	low to high
Installation cost	low	moderate to expensive
Eventual cost	low	high
Efficiency	remains high	generally deteriorates
Moisture resistance	excellent	some good, some poor
Vapor seal	simple	complicated or difficult to install
Structural strength	very good	some non-existent, others fair
Weight	very light	varies
Resilience	considerable	from fair to complete rigidity
Settling	none	a serious problem
Supporting structure	none	elaborate
Fire resistance	good	excellent to poor
Vermin resistance	good	excellent to very bad
Odor absorption	none	some are regular sponges

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Automatic

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Inexpensive

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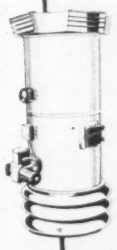

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industrial materials, products, techniques, and services, it is owned and sponsored by 13 industry associations and the Los Angeles Chamber of Commerce.

American Society of Refrigerating Engineers, 40 W. 40th St., New York City—Spring meeting, June 5 to 8, aboard ship during a cruise from Montreal on the St. Lawrence and Saguenay rivers.

With only a limited number of staterooms still available, the society is accepting reservations only for ASRE members and their immediate families. A nonmember waiting list, however, is being established for use in the event of cancellations, etc.

Heating, Piping & Air Conditioning Contractors National Association, 1250 Avenue of the Americas, New York 20—60th annual meeting, June 8 to 10, Hotel Statler, Detroit.

Stoker Manufacturers Association, 307 N. Michigan Ave., Chicago 1—1949 annual meeting, French Lick Springs, Ind., June 13 and 14. The meeting will be open to individuals and representatives of allied industries and organizations upon invitation.

The 4th International Gas Conference, June 15 to 17, London, England—Sponsored by the International Gas Union, comprised of national gas associations throughout the world. Additional information may be obtained from the American Gas Association, 420 Lexington Ave., New York 17.

3rd Annual Store Modernization Show, June 13 to 24, Grand Central Palace, New York City—Daily conferences will be conducted under the direction of the New York University School of Retailing. Admission tickets, as well as invitations, can be obtained from the school or from the Store Modernization Institute, 40 E. 49th St., New York 17.

American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York 10—1949 semi-annual meeting, June 20 to 22, Minneapolis.

National Warm Air Heating and Air Conditioning Association, 145 Public Square, Cleveland 14—Mid-year convention, June 21 and 22, Edgewater Beach hotel, Chicago.

American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.—The fifty-second annual meeting will be held at the Chalfonte-Haddon Hall hotel, Atlantic City, June 27 to July 1. The first national meeting of the society on the west coast will be held at the Fairmont hotel, San Francisco, October 10 to 14.

American Welding Society, 33 W. 39th St., New York 18—The 30th annual meeting and exposition will be held in Cleveland, the week of October 16.

As usual, the meeting will be held during the National Metal Congress and Exposition. The society has reserved a block of rooms at the Hotel Cleveland, headquarters for the meeting. When the quota is filled, room applications will be referred to the Metal Congress Housing Bureau.

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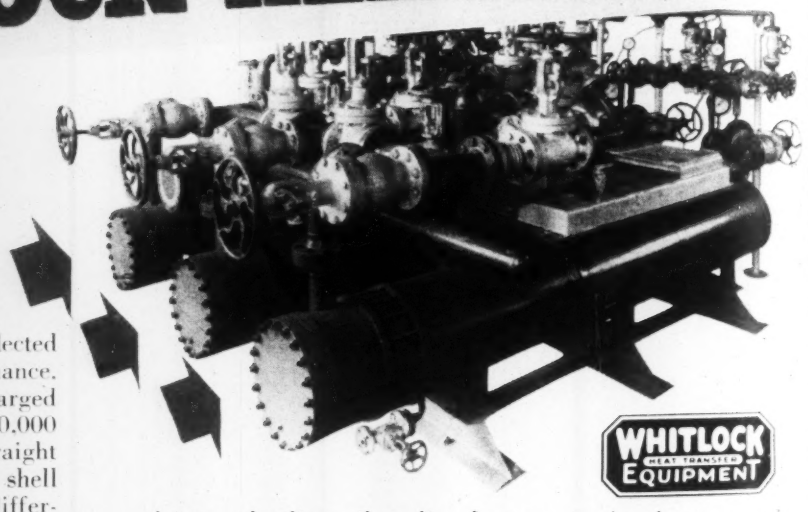
FOR THE WORLD'S LARGEST PREFABRICATED FUEL OIL HEATING AND PUMPING UNIT



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Whether your fuel oil heating requirements are "standard" or "special" there's a Whitlock heater to produce the oil temperature and viscosity you need—economically, dependably. Whitlock regularly manufactures a complete line of fuel oil heaters, loading oil or line heaters, suction heaters, and manhole coil type heaters. Whitlock engineers will gladly suggest the right unit for your requirements. Write for Bulletin 35.

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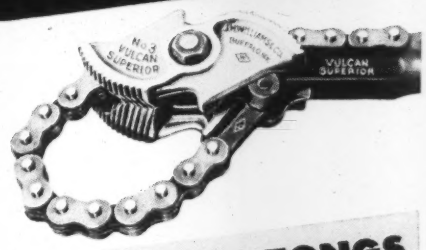

7 sizes, with either flat link or cable chain, for pipe and fittings 1/8 to 12".

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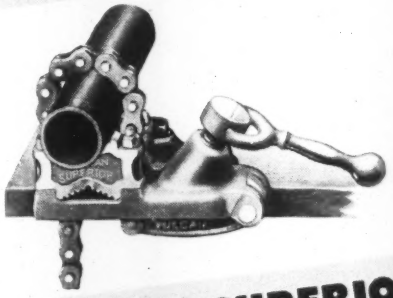
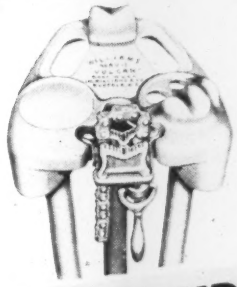


2 sizes, for pipe 1/8 to 4½". Handle is on top for easy operation.

"VULCAN SUPERIOR" VISES



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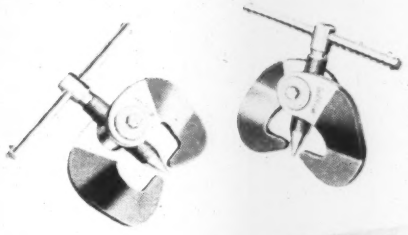

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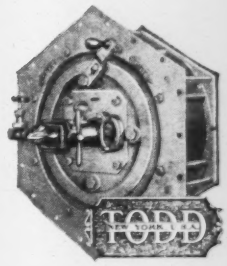

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RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 181. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning

No. 7188: Air Conditioning Coils—Catalog AC-153 on direct expansion, steam, and water air conditioning coils has been issued by Kramer Trenton Co., Trenton, N. J. The 32 page booklet gives information on ratings, dimensions, friction factors, and recommendations on how to select units. Pertinent engineering data in the form of tables on air volume, *K* factors, etc. are included.

No. 7189: Air Cylinder Maintenance—Double acting air cylinders are normally supplied on all the heavy duty water cooled compressors of Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa. Service Bulletin No. 12 recently issued by the company, is devoted to the maintenance of double acting cylinders. In addition to giving general suggestions for such operations as installing cylinder linings, the need for regular inspection and preventive maintenance is stressed.

No. 7190: Air Shutters and Penthouses—Operating features and dimensions of self closing, manually operated, and motor operated air shutters are contained in Bulletin SH-1 of L. J. Wing Mfg. Co., 154 W. 14th St., New York 11. Also briefly covered are penthouses (for ventilation directly through the roof of a building) incorporating these shutters.

No. 7191: Air Test Instruments—Illustrations, brief descriptions and prices are given in a six page leaflet issued by E. Vernon Hill & Co., 6826 W. Highland Ave., Chicago 31. Among the instruments covered are micromanometers, pitot tubes, smoke bombs, the "Borozin" smoke gun, a direct vision dust counter of the fractional sampling type, smoke sticks, a smoke tube draft gage, kata thermometers, and a number of psychrometers, including a motorized unit.

No. 7192: Aluminum Ducts—A 20 page booklet showing a number of Kaiser aluminum ductwork installations in connection with west coast air conditioning jobs has been issued by Permanente Products Co., Oakland, Calif. Advantages of aluminum for this purpose are covered and recommendations for rectangular construction are given. The data are modifications of ASHVE Guide recommendations. Also tabulated are FHA requirements (as reported in the December 1947 issue of HPAC).

No. 7193: Blast Furnace Gas Burners—Peabody Engineering Corp., 580 Fifth Ave., New York 19, has released Bulletin 500 which includes blast furnace installation pictures and cross sectional drawings of various other types of burners for waste and primary fuels.

No. 7194: Brass Tube Connectors for Copper Tubing—Catalog No. 1949CP provides detailed information on flared and compression type fittings, and small brass pipe fittings (iron pipe thread), together with double compres-

Air Conditioned with Frick Refrigeration

Three "New Eclipse" Compressors provide 117 tons of refrigeration for air conditioning the restaurants of The Brass Rail, at 521 Fifth Avenue, New York. The installation, with its excellent results, is a credit to Armo Cooling and Ventilating Co., New York Distributors of Frick air conditioning equipment.

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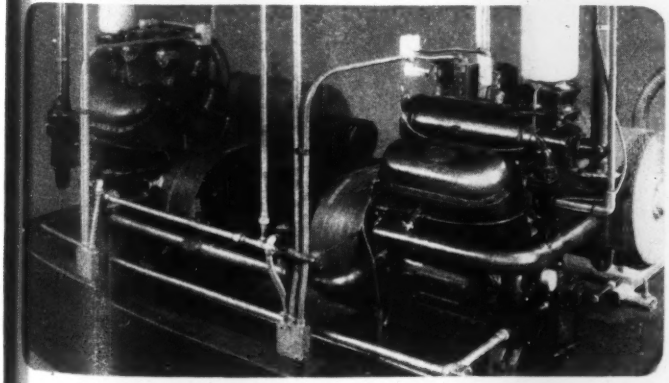
Two of Three Frick "New Eclipse" Machines at The Brass Rail



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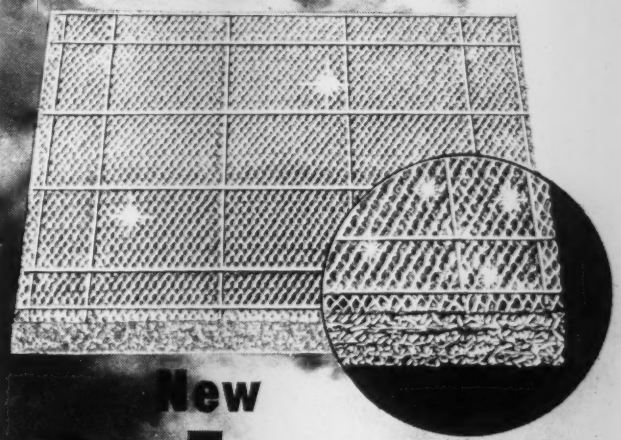
COMBINE IN THIS "WORLD'S FINEST AIR FILTER"



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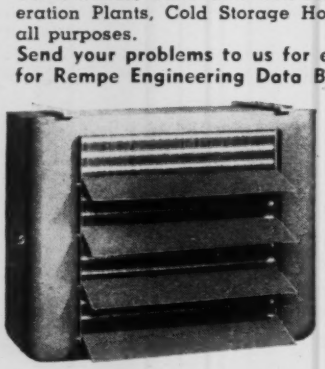

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Write for Bulletin No. 122 or send specifications for quotations.

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sion and inverted flare fittings. Also covered are drain cocks, shutoff cocks, needle seat cocks, and tubing tools. The manufacturer is Couplings Co., 55 E. 18th St., Chicago 16.

No. 7195: Bronze Alloy Welding Rod—"Bronzoc from" 185FC is a new flux coated rod for low temperature (1000 to 1200 F) welding. It is said to bond instantly to any cast iron, steel, malleable iron, galvanized iron, bronze, stainless, brass, copper, nickel, monel or aluminum-bronze. Details as to functions, advantages, and applications are given in the Vol. 6, No. 1 issue of the house organ published by Eutectic Welding Alloys Corp., 40 Worth St., New York 13.

No. 7196: Bronze Gate Valves—The Vol. 8, No. 3 issue of the house organ published by Walworth Co., Inc., 60 E. 42nd St., New York 17, features a description of the new 350 lb bronze gate valves which are recommended for service on steam up to 550 F and for nonshock cold water, oil, or gas service. Another article describes the firm's corrosion resistant valves of types 316 and 304 stainless steel, monel, nickel, and acid resisting bronze.

No. 7197: Capacitor Start Motors—The complete line offered by Emerson Electric Mfg. Co., St. Louis 21, is described and illustrated in a four page bulletin. Diagrams, dimensions, construction details, and performance data are included for these units, from $^1/_8$ through $^3/_4$ hp.

No. 7198: Cast Iron Radiator Data—A pocket manual available from National Radiator Co., Johnstown, Pa., gives dimensions, capacities, and roughing-in data on both current and obsolete types of the company's cast iron radiators. Identified as Booklet No. 539, it includes information on pedestals, hangers, brackets, etc.

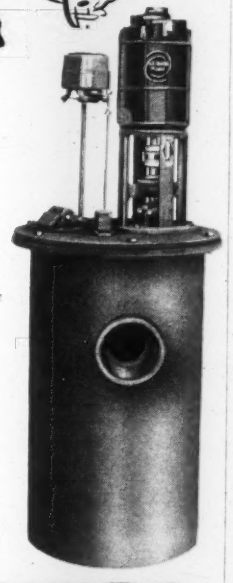
No. 7199: Compressor Selection Chart—Worthington Pump and Machinery Corp., Harrison, N. J., has released Bulletin L-640-B2, a selection chart for its type HB single horizontal air compressor.

No. 7200: Control of Scale in Heat Exchange Equipment—"Akwatrol" is a combination electrical and chemical method for automatically and continuously controlling scale in boilers, steam generators, evaporators, stills, feedwater heaters, and other heat exchange equipment. It is covered in a new four page folder issued by Apex Products Corp., 75 E. Wacker Dr., Chicago 1.

No. 7201: Copper Tube Steam Heating Elements—"Paracoil" heating elements are comprised of a number of seamless drawn copper tubes bent into U shape, with both ends of each tube expanded into rolled steel tube sheets. A flanged steel neck piece is used for insertion and welding to a tank. Elements are described and illustrated in Bulletin No. 20 issued by Davis Engineering Corp., 1064 E. Grand St., Elizabeth 4, N. J. Installation instructions are included along with sample specifications. A feature of the bulletin is a conversion table for various steam and temperature conditions.

No. 7202: Corrosion Meter—The National District Heating Association corrosion tester is an instrument which is said to measure the corrosivity of any medium wherein

If you're looking for the Correct Pump



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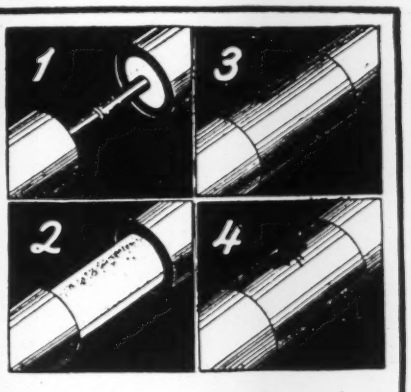

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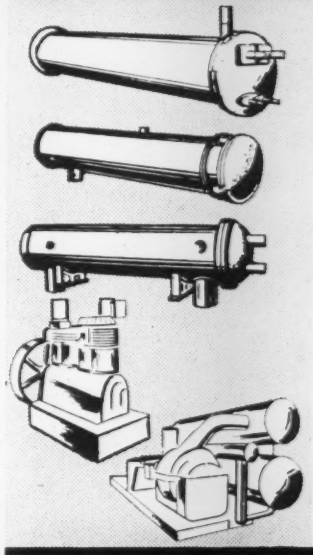

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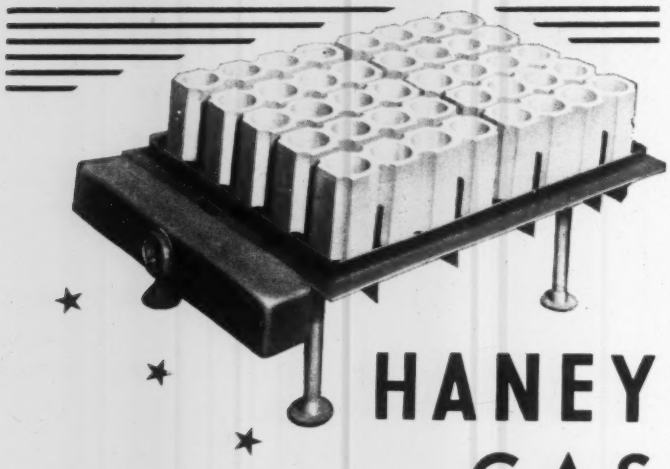

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Haney Venturi Gas Burners are the answer to all your heating installations whether commercial, domestic, or industrial. The vertical type illustrated will afford economical, even, dependable heat with remarkable freedom from maintenance troubles. It's shipped completely assembled, ready for installation and is available for mixed, natural or LP gases.

We'll be glad to send more information on request . . . please write!

HANEY GAS BURNER AND ENGINEERS

909 South Myrtle Avenue Monrovia, California

the temperature does not exceed about 400 F and where rates of flow (of liquids) do not exceed 5 fps. Two articles by Leo F. Collins, covering why and how the NDHA corrosion tester is used and how it performs, were published in the October and November 1948 issues of HPAC. Reprint copies are available from Water Doctor Laboratories, 14615 Prevost Ave., Detroit 27, manufacturer of the tester.

No. 7203: Direct Fired Industrial Air Heaters—Dravo Corp., Heating Section, Dravo Bldg., Pittsburgh 22, has published a 12 page bulletin (No. 523) on its line of "Counterflo" direct fired, forced air heaters. With capacities from 400,000 to 2,000,000 Btu per hr, heaters are fired by either oil or gas and can be obtained with combination burners. Applications, together with design and construction features such as the stainless steel combustion chambers, are covered.

No. 7204: Electric Heating Elements and Equipment—Design and construction features, ratings, dimensions, prices, applications, and installation data are given in a new catalog released by Industrial Engineering & Equipment Co., 711 S. Theresa Ave., St. Louis 3. Equipment covered includes a wide variety of strip, flat type, and cartridge heaters, together with immersion units, air heaters, blast coil or duct heaters, and oven units. Thermostats and other controls are included.

No. 7205: Electronic Timer—The Type 30HL1 is an automatic timer for intervals from 1/20 sec to 4 min and is designed for process control and machine timing where long life, repeat cycle operation and accuracy is required. It is covered in Bulletin PC478 released by Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.

No. 7206: Fan Blades and Blower Wheels—A 16 page catalog issued by Burden Co., 1000 N. Orange Dr., Los Angeles 38, gives performance and dimensional data on its line of propeller fan blades and centrifugal blower wheels. Various three and four blade types are covered as are single and double inlet wheels, together with a number of complete blower assemblies. Recommended scroll and installation dimensions are included.

No. 7207: Fans for Ventilating, Cooling—Descriptions, specifications, dimensions, and illustrations of 17 types of fans for commercial, industrial, and residential use are contained in two new catalogs issued by Chelsea Fan & Blower Co., Inc., 1206 Grove St., Irvington 11, N. J. Available in sizes from 12 to 60 in. and in capacities from 1000 to 32,000 cfm, units include window fans, attic type fans, industrial units (both belt driven and direct drive), penthouse units, paint spray booth fans, and blowers and exhausters for many industrial uses. Catalog 863 covers the smaller units and Catalog 864 deals with commercial and industrial fans.

No. 7208: Filters for Liquids and Gases—In a new folder, Dollinger Corp., 56 Centre Park, Rochester 3, N. Y., defines "Scrud" as scale, rust, dirt, etc. in air and liquid pipe lines. In answer to the problem, the company's line of "Staynew" filters featuring radial fin design is briefly described and illustrated. Available in a wide range of sizes, standard models are built to withstand 125 psi.

TOMORROW'S AUTOMATIC CONTROLS TODAY

General Controls New Compact Snap-Action T-70 Thermostat

Sets a new standard of Functional Beauty and Accuracy in room temperature control. Extending only ⅞" from the wall, the ivory plastic base and lustrous stainless cover of streamlined design harmonize perfectly with the finest taste in room decoration.

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★ Long life—rugged construction, only one moving part, double ball bearings.
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NICHOLSON TRAPS SPEED UP CIRCULATION

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7 REASONS WHY:

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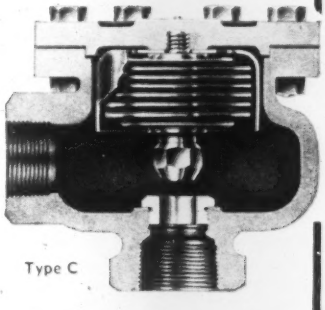
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5 TYPES for every industrial application. Sizes ¼" to 2"; press. to 225 lbs.

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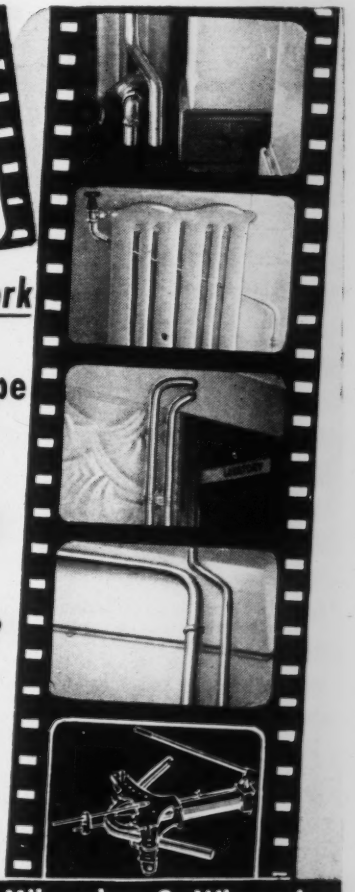
You can do *more work* every day when you bend pipe with a

TAL *Portable* Bender



Work goes faster when you bend on the job — either original installation, radiant heat or repair. Fewer joints to leak in the future, less friction, more satisfaction for your customers and a bigger profit for you. Do as hundreds everywhere are already doing. Write for illustrated data bulletin. Dept. 13

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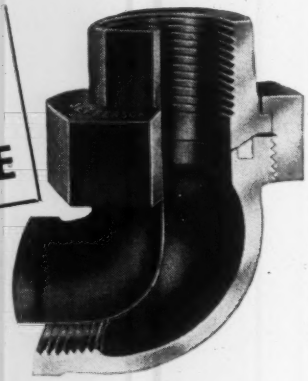

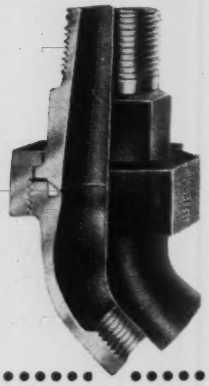

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Check with us today . . . we're sure we can show you how to simplify your piping installations.

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UNIT HEATERS
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CHROMALOX SB-9

ELECTRIC HEATING AT ITS BEST!

though special models may be obtained for pressure up to 5000 psi. Also illustrated are filters for engine, compressor, and ventilation service.

No. 7209: Hole Cutting Saws—Hole saws, replacement blades, and parts are described in a six page catalog which features a new line of "Speedex" units and improved "Hole-Master" multiple blade saws in which a single tool head holds four to 11 different sizes of rotary saw blades. The bulletin has been issued by Misener Mfg. Co., 202-8 Walton St., Syracuse 2, N. Y.

No. 7210: Nickel in Pump Parts—How the use of nickel in the construction of pump parts adds to the life of units is the subject of a booklet published by International Nickel Co., Inc., 67 Wall St., New York 5. Consisting of eight pages, the booklet discusses corrosion, corrosion fatigue, erosion, and wear. Case histories are cited.

No. 7211: Pipe Cleaning Machine—General Wire Spring Co., S. Ninth and Sarah Sts., Pittsburgh 3, has released a new folder on the "Sewerooter Jr.," a portable, motor driven unit for cleaning traps, waste lines, sewers, etc. The ¼ hp unit is designed to handle 1¼ to 6 in. pipe and the 1/3 hp unit is for 3 to 8 in. lines.

No. 7212: Protective Coating for Cold, Wet Surfaces—Bulletin 1540, issued by Dampney Co. of America, Hyde Park, Boston 36, describes "Apexior No. 3," a protective coating for cold and wet surfaces such as in water storage tanks, refrigerant condensers, air washers, coiling coils, fans, water softeners, pump interiors and exteriors, etc.

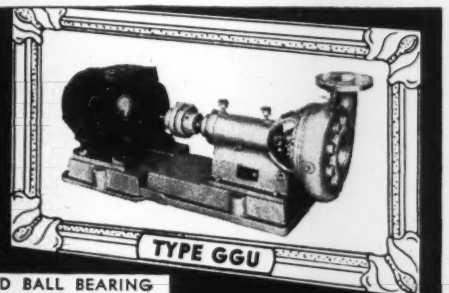
No. 7213: Refractory Castables, Plastics, and Mortars—Babcock & Wilcox Co., 85 Liberty St., New York 6, has published a bulletin (No. R-22) giving information on characteristics and applications of its refractory castables, plastics, and mortars. Many of the products are suitable for temperatures up to 3000 F, and one, "Kromecast," for 3100 F.

No. 7214: Rust Resistant Paint—Complete instructions for the use of "Rustrem" anti-rust paint are contained in Bulletin 1002-A issued by Speco, Inc., 7308 Associate Ave., Cleveland 9. Developed for hand or spray application, the manufacturer states that it can be spread over rust without wire brushing, scraping, or sand blasting as it penetrates the rust layer, renders it inactive, and seals the surface against further rusting.

No. 7215: Shielded Arc Electrodes for Nonferrous Welding—Bulletin 464, issued by Lincoln Electric Co., Cleveland 1, covers "Aluminweld," a 5 percent silicon-aluminum alloy electrode for welding aluminum in any form and "Aerisweld," a shielded arc electrode for bronze, brass, and copper. Applications, properties of deposited metal, and welding procedures are given.

No. 7216: Soldering and Brazing Torch—Sully Engineering, Ltd., 9304 Santa Monica Blvd., Los Angeles, has issued a bulletin and several mimeographed sheets giving data on the "Crown" torch which is used for soldering, light brazing, and heating operations. The unit is hand-sized, is said to burn 7 hr before refilling from any standard propane-butane tank, and burns at 2800 F.

PORTRAIT of a FINE PUMP "by Aurora"



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SIDE SUCTION CENTRIFUGAL

Capacities to 1400 G.P.M.
Heads to 190 Ft.

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APCO TURBINE-TYPE PUMPS

For high pressure, small capacity requirements (up to 150 g.p.m.). Wide operating range characteristics. No metal to metal contact. Handles non-lubricating liquids without wear. Only one moving part — the Impeller.

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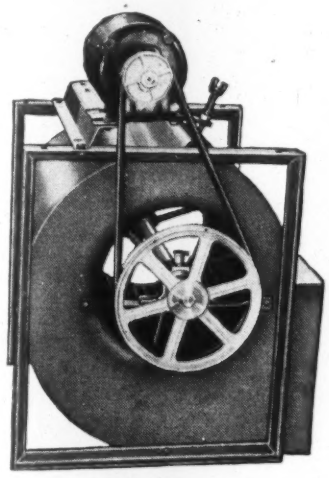

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MASSACHUSETTS . .

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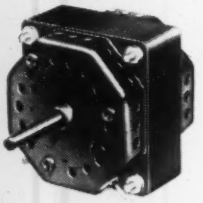
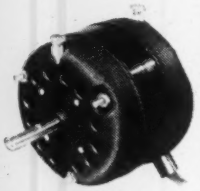
Alliance builds 4-pole and 6-pole shaded pole induction motors with speeds from 500 to 1550 rpm and from 1/100 h.p. up to 1/25th h.p. Smaller 2-pole shaded pole motors will supply as little as 1/400 h.p.

MODEL B
4-pole shaded pole motor. Approx. 1/30 h.p. 1550 r.p.m.



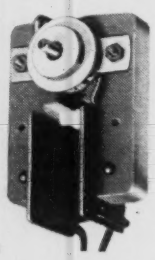


MODEL A
6-pole shaded pole motor. Approx. 1/30 h.p. 500 to 1050 r.p.m.

MODEL MS
2-pole shaded pole motor — full load h.p. .0021. Full load 2800 r.p.m.

Typical Fan Motor Uses

Air Circulators
Room Heaters
Exhaust Fans
Coolers
Air Conditioners
Unit Heaters
Hair Dryers
Controls



Write for catalog and specifications

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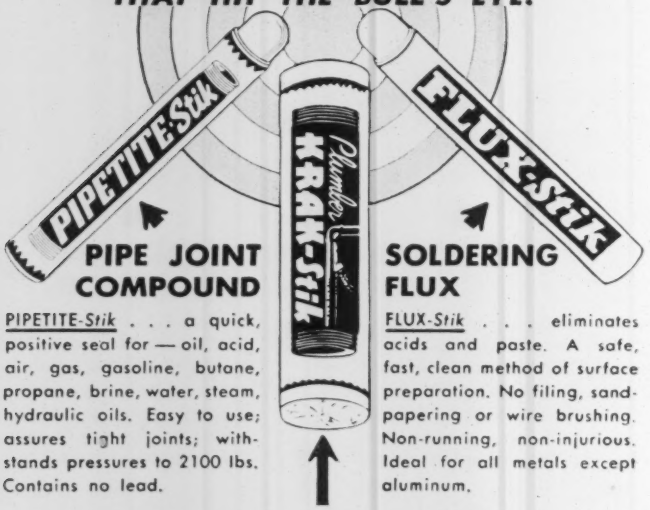
THAT HIT THE BULL'S EYE!



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No. 7217: Spray Nozzles and Water Cooling Equipment—A new loose leaf catalog, released by Binks Mfg. Co., 3122 Carroll Ave., Chicago 12, deals with "Rotojet" and "Spra-Rite" nozzles from the small ⅛ in. pipe size to large industrial sizes for use in connection with spray ponds, washing coal, blast furnace gases, etc. Vertical and horizontal cooling towers in a wide variety of sizes are also described. Specifications and drawings are included for both deck and spray filled towers operating on natural or mechanical draft. A special section is devoted to induced draft cooling towers with masonry walls, and another eight page section covers atomizing nozzles for the maintenance of constant relative humidity.

No. 7218: Stainless Steel Welding Electrodes—Information on applications, properties of deposited metal, and welding procedures is given in Bulletin 463 of Lincoln Electric Co., Cleveland 1. Electrodes described are for shielded arc welding and direct current surfacing of 18-8 and type 310 stainless, for d-c shielded arc welding of types 309 and 316, and for the 5 percent chromium steels.

No. 7219: Steam Separators—Are featured in a new catalog released by Wright-Austin Co., 315 W. Woodbridge St., Detroit 26. The booklet contains data on 29 different types of separators available in sizes from ½ to 16 in.. Charts, tables, and diagrams provide selection data and information is also given on exhaust heads of several different types. Copies of the bulletin are available to persons actively engaged in the supervision of primary steam generating equipment on written application to the company.

No. 7220: Steam Traps—Solving Steam Trap Problems is the title of a 36 page booklet published as a "guide to users" by V. D. Anderson Co., 1935 W. 96th St., Cleveland 2. Information is given on selecting the right size trap, correct trapping practice for unit heaters, jacketed kettles, autoclaves, submerged surfaces, hospital, laundry, and kitchen equipment, and steam mains and header drips. Information is also given on trap capacity factors, how to determine the lift of a trap, and condensation rates. A detailed description is given of the company's "Super-Silvertop" inverted bucket type unit, float traps, air release valves, and pipe line strainers.

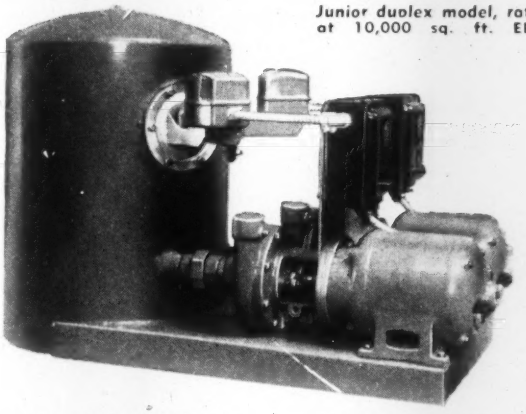
No. 7221: Stud Welding Accessories—Parts and accessories for use with its stud welding gun are identified and priced in an eight page catalog issued by Nelson Stud Welding Div., Morton Gregory Corp., Lorain, Ohio. Items include special leg attachments, spark arrestors, and a number of complete kits for special applications.

No. 7222: Underground Steam Distribution—A 34 page catalog section (480-2) has been published by Ric-wil Co., Dept. A23, Union Commerce Bldg., Cleveland. In addition to covering specifications, advantages, and installation procedures of the company's insulated pipe conduit systems, the booklet provides data on such factors as layout of the route, estimating steam loads, pipe sizing and friction losses, capacities of condensate return piping, properties of steel pipe, recommended steam velocities, properties of saturated steam, etc. Catalog section 480-3 contains 35 odd drawings showing piping layouts for the firm's insulated units as applied to industrial, educational, government, railway, hospital, and housing applications.

Condensation Pumps

Rated from 1,000 to 100,000 sq. ft. EDR

Junior duplex model, rated at 10,000 sq. ft. EDR.



When the job calls for 10,000 sq. ft. EDR with double capacity or standby pump, it's a job for this Whittington junior duplex condensation pump. Capacity—1½ to 15 gpm at maximum discharge. Discharge pressure—20 to 40 lbs. psi. Floor space required—18" x 34". Ball bearing, oil lubricated, standard motors. Only motor bearings require lubrication. Rotary seals eliminate packing glands on centrifugal pumps. Other models—single and duplex—with ratings from 1,000 to 100,000 sq. ft. EDR described in Bulletin C-47. Whittington Pump & Engineering Corp., 1126 Prospect St., Indianapolis 3, Indiana

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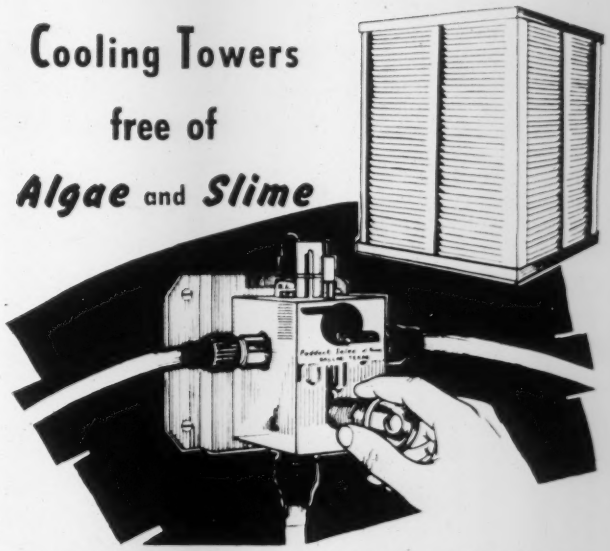
Cooling Towers free of *Algae* and *Slime*



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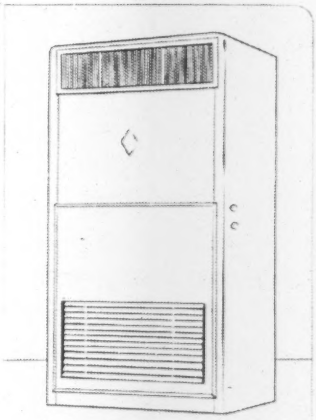

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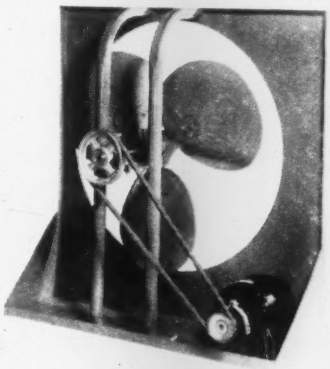

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